Universität Zürich[UZH]

Consonant Quantity and Positional Neutralisation

Heusler's Law and Winteler's Law in Zurich German

Thesis

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Contents

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Introduction

Zurich German, a High Alemannic dialect spoken in the area of Zurich, has short and long obstruent series leading to minimal pairs such as [huːpə] 'hood' – [huːpːə] 'honk (inf.)'; [ofə] 'oven' – [ofːə] 'open (adj.)'. Phonetically, Zurich German also displays short and long sonorant consonants, as e.g. in [ʃtɒːl] 'steel' – [ʃtɒlː] 'barn'.

In his highly influential work on the Kerenz vernacular, Jost Winteler (1876) recognised that the obstruent stops are neither voiced nor aspirated. Winteler assumed that the distinction is made by a difference in intensity, and therefore proposed the terms *fortis/lenis* to distinguish the series. In his view, *fortis* obstruents are of higher intensity and sometimes accompanied by longer duration.

Early work on Swiss German dialects by Winteler (1876) and Heusler (1888) state that the contrast is systematically neutralised in specific contexts. In Swiss dialectology, these observations are known as Heusler's Law and Winteler's Law.

Heusler's Law states that if two or more obstruents cluster, their articulation is "of medium intensity": stronger than *lenis,* but weaker than *fortis*. Heusler (1888: 24) suggests the term 'neutral' for these sounds. According to Winteler's Law, sonorant consonants are long when followed by an obstruent (cf. Winteler 1876: 142f.).

Heusler's Law and Winteler's Law describe the suspension of a contrast in a particular context, a phenomenon traditionally termed neutralisation. While it is regularly mentioned in dialect grammars, there are virtually no empirical studies available. On the one hand, the question therefore is whether these laws actually have an empirical basis. On the other hand, they raise a number of theoretical issues.

First, the articulatory nature of the *fortis/lenis* opposition was never quite clear. Finding a phonetic correlate to articulatory strength proved difficult. For Zurich German, there is no empirical evidence that *fortis* consonants are articulated with more intensity than the *lenis* counterparts. Rather, studies found that the phonetic correlate for *fortis* consonants is duration (cf. Willi 1996). This raises the question of whether the *fortis/lenis* distinction is better understood with reference to suprasegmental properties. This position is also taken in the present work.

Secondly, Heusler's Law is problematic under standard assumptions about neutralisation. According to Heusler, the neutralised sound is somewhere between the *fortis/lenis* poles. Since neutralisation is commonly understood as the removal of an underlying contrast "in favour of the unmarked segment" value (Hall 2000: 97), Heusler's type of neutralisation is quite unanticipated and has received comparatively little theoretical attention.

Phonological theory usually considers distinctive length a suprasegmental property. Since *fortis* consonants are phonetically longer than their *lenis* counterparts, the question is whether there are phonological arguments in support of a suprasegmental analysis, in other words, whether the contrast can be understood as a singleton/geminate opposition. The representation of geminates has been the subject of a lively debate among phonologists. While there is a consensus that the distinction between singletons and geminates is on a suprasegmental level, the views on how to represent the contrast differ. There are two prevailing theories: X-Theory represents the contrast in terms of length, whereas Moraic Theory captures it in terms of weight.

This adds a third point. If *fortis/lenis* is not a segmental property, neutralisation cannot be explained on a segmental level either.

In the present thesis, I will argue that the *fortis/lenis* distinction is indeed an opposition between geminates and singletons. Evidence from various prosodic processes suggests that the contrast is best represented in Moraic Theory, as it provides a uniform explanation for Heusler's Law and Winteler's Law.

This dissertation aims to shed new light on the nature of the neutralisation. It is organised as follows: Chapter 1 sketches general aspects of Zurich German, in particular, its linguistic classification, its geographical distribution and its sociolinguistic status. Chapter 2 gives an overview of the Zurich German sound inventory with a particular focus on the consonants and relevant phonological processes. In addition to Heusler's Law and Winteler's Law, a third process, Monosyllabic Lengthening, will play a crucial role.

Winteler's legacy proved enduring not only in Swiss German dialectology, but it also found its way into many linguistic descriptions, sometimes with conspicuously differing interpretations. Chapter 3 offers a brief historical outline. An essential aspect is that with the advent of Generative Phonology, the relationship between phonetics and phonology gained theoretical importance and the lack of a unique phonetic correlate for *fortis/lenis* became problematic. In light of this disadvantage, alternatives have been put forward, two of which are considered here: one that replaces *fortis/lenis* with Voice Onset Time (Lisker & Abramson 1964), and a second that replaces it with a length contrast.

Chapter 4 discusses the theoretical modelling of length in detail. Under the widely held assumption that long consonants are geminates, length is no longer considered a feature but is expressed by association with other autosegmental levels. The chapter lays out the general assumptions on the representation of geminates. An emphasis is placed on the two prevalent theories: X-Theory (e.g. Levin 1985) and Moraic Theory (Hayes 1989).

In Moraic Theory, the representation of geminates is closely related to syllable weight. Assuming that geminates are units of weight, we expect them to be involved in prosodic processes related to syllable weight. 4.3 provides evidence for a geminate/singleton analysis of Zurich German. I will argue that the supposed *fortis/lenis* distinction is actually a contrast between geminates and singletons. Particularly with regard to word minimality and stress assignment, there is evidence that the *fortis* consonants contribute to syllable weight.

Chapter 5 concerns neutralisation, the central question being how Zurich German neutralisation processes should be captured on a suprasegmental level. In her skeletal-based analysis, Kraehenmann (2003) takes a templatic view proposing a limited amount of X positions to account for Heusler's Law. If the contact of two obstruents exceeds this limit, an X position is eliminated. Neutralised consonants are thus interpreted as singletons. This seems somewhat at odds with the observation found in dialectological work where the (phonetic) outcome of the neutralisation is considered *fortis* or *fortis*-like ("half-fortis", cf. e.g. Moulton 1986: 386). Kraehenmann's analysis will be reviewed in some detail in 5.2.3. 5.2.4 discusses how neutralisation can be dealt with in Moraic Theory. The key argument is that inherently moraic (i.e. geminate) consonants cannot be distinguished from positionally moraic consonants (Weight-by-Position, cf. Hayes 1989). Since geminates and singletons differ exclusively with respect to the presence (or absence) of an associated mora, Moraic Theory predicts neutralisation in coda position. Phonetically, the result is a long consonant, mirroring the intuitions of the dialectologists. Winteler's Law provides further evidence for the proposed analysis. I will argue that Winteler's Law represents an instance of positional neutralisation, which can be explained straightforwardly under standard assumptions of Moraic Theory.

Despite the prominent place Winteler's Law and Heusler's Law take in dialectological literature, empirical validation is still lacking. The majority of phonetic studies on SwG consonants concerned obstruents in non-neutralised contexts. Chapter 6 aims to fill this gap by measuring the duration of neutralised consonants as well as examining the factors that are likely to affect the outcome. The chapter starts off with an overview of previous phonetic studies. It is followed by a description of the key research questions and general methodology for the investigation at hand. The main goal is to determine whether the intuitive impression that neutralisation leads to intermediate values is confirmed by the measurements. Phonetic corroboration would also support a mora-based analysis that accounts for neutralisation of suprasegmental properties as positional neutralisation. The results are presented in section 6.3. Chapter 7 summarises the main findings and concludes the thesis by giving its limitations as well as the perspectives for future research.

1. Preliminary remarks on Zurich German

The following chapter gives an overview of Zurich German (henceforth: ZG). Its linguistic classification within the German language family is outlined in 1.1. The area where ZG is spoken is identified in the following section. It will become clear that several regional variations fall under the label *Zurich German*. However, there are some characteristics that are considered typical for ZG. 1.2 provides the isoglosses which separate ZG from neighbouring dialects. The linguistic situation in the German-speaking part of Switzerland is sketched in 1.3. It is well-known that the complementary use of dialect and Standard German has made Swiss German a textbook example for diglossia (Ferguson 1959). The section focuses on the parameters which condition the distribution of dialect and the standard language, and briefly discusses the impact of (social) prestige on the choice.

1.1. Linguistic classification

ZG is an Upper German dialect. Its linguistic borders roughly correspond to the political borders of the Canton of Zurich, Switzerland. With a few exceptions (most notably the dialect of the City of Basle) Swiss German dialects belong to the High Alemannic or Highest Alemannic branch. The most salient feature for High (and Highest) Alemannic dialects is the complete execution of the Old High German (OHG) Consonant Shift, including the shift of word-initial Germanic *k > /x/, as e.g. in /xint/ 'child', /xɒlt:/ 'cold'. The k/x isogloss is the southern-most green line in the map in Fig. 1, below.

The dotted red lines in Fig. 1 indicate the national borders. The bold green line indicates the isoglosses that cut off High German from Low German. Low German, spoken North of the line, has not undergone the OHG Consonant Shift. South of the line, the OHG Consonant shift was (at least partly) carried out.[1]

[1] In modern German, the term *Hochdeutsch* 'High German' is ambiguous. As an areal term, it comprises the Upper and Central German dialects and is thus opposed to Low German dialects. The adjectives *high* and *low* are geographical terms referring to the 'high' Alps in the South vs the 'low' North Sea. In everyday language, however, *Hochdeutsch* is a synonym for the standard variety. In this sense, *Hochdeutsch* and dialect are opposites. Therefore, people typically express their surprise when they learn that Swiss German dialects linguistically belong to High German. In the present thesis, High German is only used as a linguistic term. Whenever I refer to the standard variety (which is also a High German variety), I use the term Standard German.

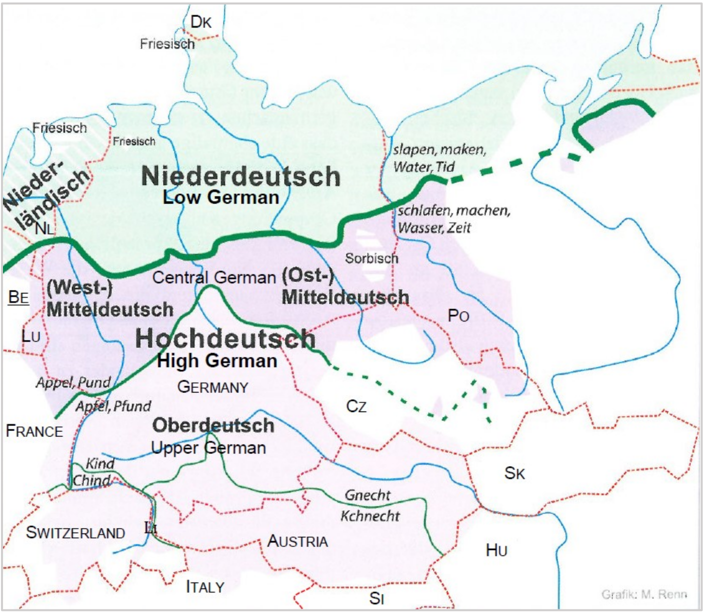

Fig. 1: Dialect areas of German (until 1945). Taken from Christen et al. (2015: 17 [country names (ISO codes) and English translations added by KW])

As Fig. 2 illustrates, High and Highest Alemannic dialects are spoken in the southernmost regions of the German-speaking area. High Alemannic is also spoken in Liechtenstein, some areas of Alsace (France), and in neighbouring areas of Austria and Germany. Highest Alemannic is spoken in alpine regions of Switzerland, in Liechtenstein, Vorarlberg (Austria), and a few linguistic islands in the Italian Alps. Low Alemannic is spoken in and around the City of Basle as well as in the South-West of Germany.

Fig. 2: Dialect classification of Upper German. Taken from Christen et al. (2015: 30 [English translations added by KW])

1.2. Zurich German: sub-varieties and neighbouring dialects

Züritüütsch ‘Zurich German’ is the language name used in everyday speech to refer to the dialect spoken in the Canton of Zurich. Speakers of a Swiss German dialect typically have a general knowledge of the characteristics of a dialect and are thus capable of allocating it to an approximate area. As a rule, the dialects are named after the Canton where it is most prominently spoken (e.g. Baseldeutsch ‘Basle German’, Berndeutsch ‘Bernese’, Thurgauerisch ‘Thurgovian’; on the relevance of Cantons to categorise dialects, cf. also Christen 1998b: 260). In so doing, the speakers take some typical features of the region as a reference point. Phonetic features seem to be particularly salient (see e.g. Christen 1998b, Leemann & Siebenhaar 2008, Guntern 2011, Ruch 2018).

According to Weber (1948: 19ff.), the area where ZG is spoken by and large conforms with the political territory. Additionally, ZG is spoken beyond the cantonal borders in the South-East, especially in the area around the Lake of Zurich. The *Weinländer Mundart* (vernacular of the Weinland), which is spoken in the North of the Canton of Zurich is not considered ZG. I will come back to this issue momentarily.

In his fairly conservative grammar on ZG, *Zürichdeutsche Grammatik,* Weber (1948: 20ff.) distinguishes five subareas as shown in Fig. 3.

- *Oberländer Mundart (O.):* vernacular of the Oberland (upper part of the canton of Zurich)
- *Winterthurer Mundart (W.):* vernacular spoken around the City of Winterthur
- *Unterländer Mundart (U.):* vernacular of the Unterland (lower part of the Canton of Zurich)
- *Ämtler Mundart (A.):* vernacular of the (Knonauer) Amt (the area around Knonau, often called Amt ‘county’)
- *Stadt-Mundart (St.)* and *Seemundarten (S.):* vernaculars of the City of Zurich and the villages around the Lake of Zurich[2]

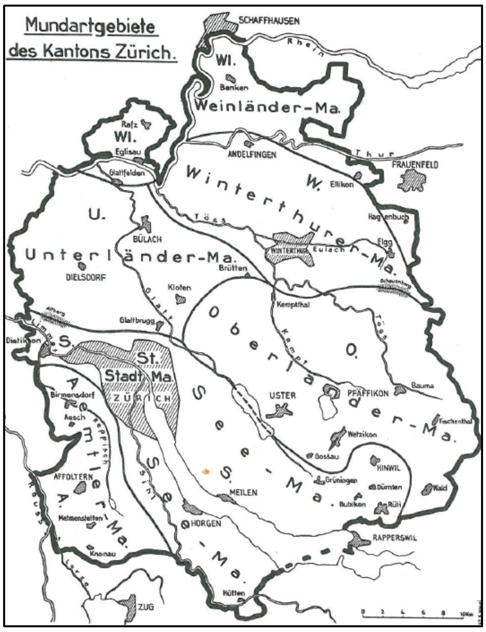

Fig. 3: Vernaculars of Zurich (Weber 1948: 383)

[2] Both areas are treated as one vernacular in Weber (1948: 22).

Compared to other dialects, ZG is reported to be fairly homogeneous (e.g. Keller 1961: 35; Schobinger 1993: 26). The differences between the varieties in Fig. 3 are relatively small.[3] The features of the area around the City of Zurich are viewed as prototypical for ZG. The interaction of a few salient features led to the dialect areas in Fig. 3. They are given in Fig. 4. I comment them in the legend below.

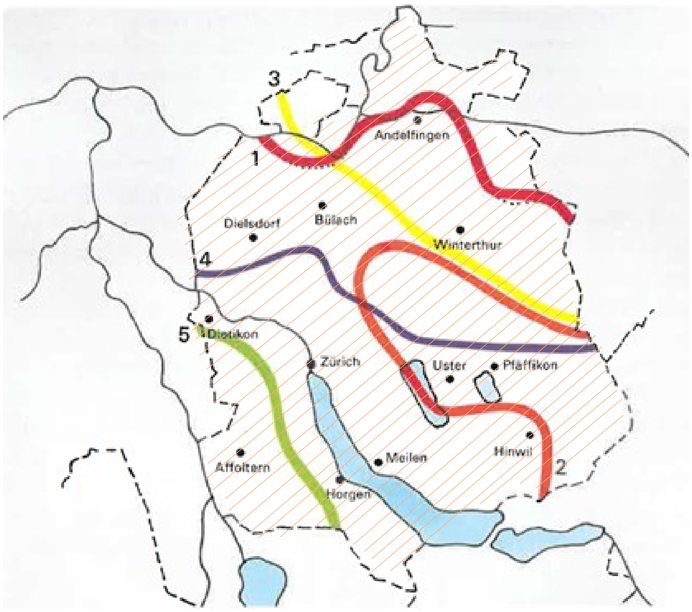

Fig. 4: Isoglosses (Schobinger 1993: 28; the hatched area indicates the Canton of Zurich)

- [ɛ] – [æ], e.g. ɛŋ – æŋ 'narrow'
  The region North of the isogloss corresponds to the Weinland vernacular, which is not regarded as ZG albeit on the cantonal territory. ZG distinguishes three degrees of aperture [e], [ɛ], and [æ], the Weinland vernacular has only a two-way distinction, [e] and [ɛ]. It is sometimes referred to as "Schaffhauserdeutsch" (German of the Canton of Schaffhausen, which borders on the North).
- [ɒː] – [ɔː] isogloss, e.g. ['ɒːpik] – ['ɔːpik] 'evening'
  The [ɔː] variety corresponds to the vernacular of the Oberland. The [ɒː] variety is much more widespread, probably due to the influence of the City of Zurich
- *nid / nöd* 'not'
  The lexical variant *nöd* with rounded [ø] is a shibboleth for ZG. The majority of Swiss German dialects have unrounded *nid* (or *ned*). *Nid* is also common in the Winterthur vernacular. However, it is not considered typical for ZG.
- *e / es Chind* 'a child'
  The Southern variant of the indefinite article neuter *es* is prevalent within the cantonal borders and is considered typical for ZG.
- geminate sonorant consonants, e.g. [ʃʊymːə] – [ʃʊymə] 'swim (inf.)'
  The Western geminate pronunciation is rare in ZG and appears only in certain regions of the Knonauer Amt district.

3 Weber (1948: 19) mentions two reasons: first, the political and confessional stability of the Canton of Zurich since the late Middle Ages, and second, the smooth and therefore accessible topography which facilitated mutual exchange and mobility.

The ZG dialect described in the present study represents the vernacular spoken in the above-described core area that can be defined by the *e/es* line in the North and the [ɒː] – [ɔː] line in the East. Furthermore, it does not display geminate sonorants (but see 2.3.2.1). It corresponds to the vernacular of the City of Zurich and around the Lake of Zurich. If not otherwise stated, I will refer to that variety.[4]

To my knowledge, an examination of the extent to which the varieties mentioned above still exist is still pending. Schobinger (1993: 27) emphasises that the isoglosses in Fig. 4 refer to "the first half of the 20th century". The growing attractiveness of the City of Zurich and the increasing mobility of the population undoubtedly contribute to the convergence of dialectal forms. Schobinger (2008: 46) laments the decline of the sub-dialects and explicitly mentions that younger speakers generally use the "urban variant" [ɒː].[5]

1.3. Sociolinguistic status

Due to its geographical location at the borders of Germanic and Romance Europe, Switzerland is divided into four linguistic regions: German, French, Italian, and the Rhaeto-Romance language Romansh. German is the language spoken by the majority of the inhabitants. According to the national census in 2014, roughly two-thirds (63.3%) of the population declare German their main language.[6]

Swiss German dialects are often referred to as Swiss German (henceforth: SwG), which is a cover term for the German dialects spoken in Switzerland. Although High Alemannic is spoken outside the Swiss borders, too, it is not considered Swiss German.[7] Christen et al. (2015: 31) note that there is "not a single dialect feature that

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4 The majority of my informants speak this variety, cf. Table 11. Two of the informants (01 and 03) spent their childhood in the Amt region, but neither has the geminate pronunciation described above. Speaker 05 is originally from the City of Zurich. She has been living in the Amt for many years without having adopted any of the characteristics of the Amt vernacular. Although I was born and raised in a village of the Amt myself, I find the geminate pronunciation utterly foreign.

5 See Schmid (2004: 98) for a brief survey on the dialectological literature: Rounded [ɒ] – "stark verdumpftes a" – is documented for the dialect of Winterthur by Keller (1961), for several parts of the Canton of Zurich, including the City, by Willi (1996) as well as on several dialect maps in the *Sprachatlas der deutschen Schweiz (SDS).* Schmid conjectures that rounding is a socio-linguistic variable where urban people from the middle and upper class tend to unrounded [ɑ]. Fleischer & Schmid (2006: 246ff.) posit a phoneme /ɒ/ and consider [ɑ] a free allophonic variant.

6 Cf. *Bundesamt für Statistik,* 2016. French is spoken by 22.7%, Italian by 8.1%, Romansh by 0.5%. 20.9% named another language. The total exceeds 100% as multiple answers were possible.

7 An exception may be the High Alemannic spoken in Liechtenstein. This may partly be due to the close political and economic relationship between the two countries. However, it should be noted that many Swiss cannot distinguish Liechtenstein Alemannic from the variety spoken in the Canton of Grison and thus 'mistake' it for Swiss German.

qualifies for the demarcation of Swiss and non-Swiss dialects”.[8] Although the “linguistic homogeneity [of SwG dialects] is rather nebulous” (Keller 1961: 31), the conception of SwG dialects as a unit has high functional relevance: by subsuming the actual dialectal diversity under the umbrella term “Swiss German”, it can be used as a means of identification and distinction.

From a sociolinguistic perspective, the linguistic status of Swiss dialects is unique. In the German-speaking part of Switzerland, everyone speaks a dialect while the official language is Standard German (henceforth: StG), which is also the language for written matters. This particular use of two varieties has been termed ‘diglossia’ (Ferguson 1959). Contrary to Ferguson’s equation of “higher level” = standard language, “lower level” = dialect, Swiss dialects are not socially stigmatised and speaking them indicates neither social status nor education. Berthele (2004, 2010) underscores the prestigious status of dialects for their speakers. They are used in any oral communication by students and mechanics, between bank managers and their clients, no matter whether the speaker has a doctoral degree or not, no matter whether the subject is biochemistry or the latest gossip.[9] There are only a few situations where StG is spoken: in school, on certain formal occasions, in some broadcasting formats such as the news.[10] The fact that StG is almost exclusively used for written communication has led to the term *Schriftdeutsch* ‘written German’, which is used in the German-speaking part of Switzerland as a synonym for StG.[11]

The official language for written matters is StG, and its spelling rules are learnt at school. SwG dialects, on the other hand, lack a binding orthography. There is a

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8 Orig: “Es lässt sich kein einziges Dialektmerkmal nennen, das sich zur Grenzziehung zwischen schweizerischen und nichtschweizerischen Dialekten eignen würde.”

9 Drawing on the concept of *Abstand* and *Ausbau* languages initially introduced by Kloss (1967), Swiss German dialects are sometimes called “Ausbaudialekte” (Christen 2007). *Ausbaudialekte* expand their range of application to areas that are traditionally reserved for standard languages. Swiss German dialects are used irrespective of subject or recipient, thus vocabulary (and to a lesser degree also structures, cf. e.g. Christen 1998a, b) is constantly incorporated into the language and adjusted to its grammatical (especially phonetic) demands.

10 The standard language taught at school is called Swiss Standard German. It differs from other varieties of StG mainly with respect to lexical idiosyncrasies and some phonetic aspects that are due to dialectal interference. Spoken Swiss Standard German has traits of a spelling pronunciation as it closely follows the written representation of the standard language (see Hove 2002). Although Swiss Standard German is an official variant of the standard language, many Swiss seem to feel uneasy with it, finding it inferior to the standard variety spoken in Germany. Reasons for this misconception may be the unawareness of the pluricentric nature of the German language, the dominant role of Germany as well as the generally felt unnaturalness to use the standard variety in oral communication (see e.g. Schläpfer et al. 1991; Ammon 1995; Rash 1998; Hägi & Scharloth 2005; Scharloth 2005; for a somewhat different view see Schmidlin 2011).

11 As a matter of fact, we can observe an increasing use of dialect in written communication, especially in social media. This may be due to the informal and dialogic character of such contexts in the sense of Koch & Oesterreicher’s (1985) “conceptual orality” in their immediacy-distance model (cf. e.g. Aschwanden 2001; Christen 2004; Haas 2004; Dürscheid 2016).

guideline developed by Dieth (1938). Dieth's *Schwyzertütschi Dialäktschrift* is largely phonemic and is used primarily in grammatical descriptions. It plays no role in everyday life; in fact, few people are aware of its existence, and even fewer are familiar with the rules.

With approximately 1.5 Million inhabitants, Zurich is the Canton with the largest population. About three-quarters of the population are Swiss. Although there are no exact figures how many people speak ZG, we can safely assume that ZG is the variety spoken by over a million people.[12]

1.4. Literature on Swiss German dialects

SwG dialects are very well documented, which is probably due to their popularity and predominance in everyday communication. There is a large volume of sociolinguistic studies exploring the diglossic situation in Switzerland.[13] Furthermore, we find a wide range of dictionaries, some of which cover relatively large dialect areas, some are limited to a single village. Dictionaries on ZG are Weber & Bächtold (1961) and Gallmann (2015). Grammatical descriptions are available for several dialects. The comprehensive grammars of ZG by Stucki (1921) and most prominently by Weber (1948) are fundamental to the present work. Besides, the work of Baur (1974, 1983), Keller (1981) and Schobinger (2006, 2007, 2008) have been taken into account. Apart from the brief outline by Reese (2007), whose main focus is on morphology and syntax, there are no recent descriptions of ZG.[14]

In addition to the vast amount of literature on Swiss dialects, we find several recent phonetic studies (most notably Willi 1996; see also Section 6.1). Phonological analyses, on the other hand, are sparse. Apart from Moulton (1986), insightful overviews of present ZG phonetics and phonology are offered in Fleischer & Schmid (2006) and Reese (2007). The work of Haas (1978) on SwG vowel systems, Kraehenmann (2003) on Thurgovian, Seiler (2005b) and Ham (1998) on Bernese, and

12 Cf. *Statistisches Jahrbuch des Kantons Zürich,* 2018 (28th ed., February 2018, available online at https://statistik.zh.ch).

13 The German Department of the University of Zurich provides a comprehensive database of linguistic research on SwG: http://www.ds.uzh.ch/dialbib/index.php.

14 Schobinger's (2007) *zürichdeutsche kurzgrammatik* is primarily based on Weber. Although he (2007: 9) claims to describe present-day ZG, some of the forms noted seem to be no longer in use. For instance, he presents an elaborate system of subjunctive and conditional forms no one I asked was familiar with. It must be borne in mind that Schobinger's main goal is to provide the interested layperson with a useful reference guide. His remark that the dialect has "dumbed down" [verflachen] indicates that the normative traits are intentional.

Spaelti (1994) on the dialect of Glarus belong to the few theoretical analyses available. Seiler (2009), Page (2001, 2013) and Lahiri & Kraehenmann (2004) have investigated SwG phonologies from a diachronic perspective. To my knowledge, the phonological system of ZG has not yet been discussed in a broader theoretical context. The following chapters aim to fill this gap.

2. The Zurich German sound system

In this chapter, I provide an overview of the phoneme system of Zurich German. The earliest work on ZG is Stucki (1921). His philological survey offers valuable insight into the phonology and morphology of ZG. The reference grammar for subsequent work is Weber's *Zürichdeutsche Grammatik* from 1948. A concise overview of the ZG phonology under synchronic and diachronic perspective is Keller (1961). Further descriptions can be found in Schobinger (2007) and Reese (2007), the former being aimed at a lay public. Fleischer & Schmid (2006) is indispensable for a contemporary view on ZG phonetics and phonology. It is critical to note that all studies are strongly related to Weber's *Zürichdeutsche Grammatik,* which is taken as a reference point for the present thesis, too. Many of the examples cited are from Weber (1948), with some of my own.

Before turning to the description of the ZG phoneme system, it is important to clarify the transcription of Swiss German obstruents in 2.1. This seems imperative since I will not adhere to the traditional convention. An overview of the vowel system is given in 2.2. Section 2.3 provides a detailed discussion of the ZG consonants. 2.3.1 is dedicated to the obstruents, followed by 2.3.2 on the sonorant consonants. 2.4. is on relevant phonological processes. Heusler's Law and Wintelers's Law, which are at the core of the present thesis, are presented in 2.4.3 and 2.4.4, respectively.

2.1. A preliminary note on the transcription

Traditionally, it is assumed that SwG dialects have a *fortis/lenis* contrast. The distinction goes back to Winteler (1876). For his dialect, the *Kerenzer Mundart* (vernacular of the village of Kerenz, Canton Glarus), Winteler found that obstruents do not contrast in terms of voicing or aspiration. The transcription in (1) reflects this. *fortis* obstruents are represented as ordinary voiceless obstruents, and *lenis* obstruents are transcribed as voiced obstruents with a diacritic to mark their voicelessness (b).[15]

(1) a. Scha[t]e 'shadow' hei[s]e 'call (inf.)'
    b. Scha[d̥]e 'damage' hei[z̥]er 'hoarse'

[15] The matter is somewhat more complex, see Fleischer & Schmid (2006: 245).

The notation in (1) is somewhat misleading, as it suggests devoicing of an underlyingly voiced obstruent. This implication can at best be supported on diachronic grounds. As a rule of thumb, Middle High German (henceforth: MHG) voiced obstruents correspond to ZG *lenes.* Accordingly, voiced obstruents in StG roughly correspond to ZG *lenes,* too. From a synchronic viewpoint, however, there is no evidence of a devoicing process. Both obstruent series are underlyingly voiceless.[16]

The nature of the *fortis/lenis* distinction is discussed in more detail in Chapter 3, but suffice it for now to point out that *fortes* are phonetically longer than *lenes*. Departing from conventional practises, I will transcribe the consonant pairs solely in terms of length, as shown in (2).

(2)	a.	Scha[tː]e 'shadow'	hei[sː]e 'call (inf.)'
	b.	Scha[t]e 'damage'	hei[s]er 'hoarse'

Following previous work by Kraehenmann (2001, 2003), I assume that the *fortis/lenis* opposition is, in fact, a geminate/singleton contrast. Phonetic evidence in support of this view is provided in Chapter 6. On the phonological motivation of the singleton/geminate analysis, see 4.3.[17]

One possible drawback of the transcription in (2) is that it could affect the quick recognition of the etyma – at least to the reader familiar with German spelling. The StG words *Haube* 'hood' and *hupen* 'honk (inf.)' in (3) serve as an illustration. However, the benefits of a transcription which does not suggest underlying voicing outweigh the disadvantages.[18]

(3)			singleton *(lenis)*	geminate *(fortis)*
	a.	traditional transcription	Huu[b̥]e	huu[p]e
	b.	transcription used in this thesis	Huu[p]e 'hood'	huu[pː]e 'honk (inf.)'

16 See Ham (1998) for an alternative view. In his study on Bernese, he terms *lenes* "devoiced". Evidence for this analysis is essentially historically motivated. Keller (1961: 45) explicitly remarks that the "lenis sounds are short and weak in intensity, but without a noticeable or relevant amount of voice". Phonetic measurements conducted by Brunner (1953) report that *lenes* obstruents are occasionally voiced. However, this should better be seen as coarticulation, since voicing occurs only in intersonorant position, especially after sonorant consonants (Ladd & Schmid 2018). Tissot et al. (2011), Schmid (2012), and Morand et al. (2019) also showed that speakers from migrant families of non-German background often pronounce *lenis* consonants as voiced, even word-initially.

17 Weber (1948) also mentions geminates, but only when they appear intervocalically, e.g. scha[fː]e 'work (inf.)'. Consonant length is not perceived as a phonological property in his description. Rather, it is a by-product of *fortis* consonants in a specific environment. In other words, they are *geminated* consonants that are in allophonic distribution with non-geminate *fortes.*

18 The transcriptions provided in the grammars available are diverse. Some (e.g. Weber 1948; Schobinger 2007) adhere to Dieth's (1939) spelling conventions, others have their own system. Here and throughout, I will uniformly render the varying dialect transcriptions in IPA. Generally, geminates are represented with the diacritic length symbol 'ː'. At times, I will also use double symbols (e.g. pp) to illustrate that the syllable boundary runs through the geminate.

2.2. Vowels

Zurich German and SwG dialects in general have a comparatively large set of vowels. The following subsection addresses the inventories and distribution of ZG monophthongs and diphthongs, as well as the unstressed vowel schwa.

ZG has the following monophthongs:

	short V	long V			short V	long V	
i	ʃilə	t͡siːlə	‘squint (inf.)’; ‘target (inf.)’	u	ʊulə	suːlə	‘wool’; ‘wallow (inf.)’
y	pysi	t͡syːk	‘cat’; ‘stuff’	o	pːolə	pːoːlə	‘pollen’; ‘Poland’
e	xelə	k͡xeːlə	‘ladle’; ‘throat’	ɒ	ʃɒrə	ʃɒːrə	‘paw (inf.)’; ‘crowds’
ɛ	hɛrə	lɛːrə	‘gents’; ‘empty (inf.)’	æ	ʃtækə	ʃtæːk	‘stairs’; ‘small bridge’
ø	pøkə	pøːkːə	‘bows’; ‘bogies’				
œ	ʃnœrə	ʃpœːtːər	‘chat (inf.)’; ‘later’				

Table 1: ZG vowel inventory

As shown in Table 1, ZG has distinctive vowel quantities that do not correlate with vowel quality.[19] According to Weber (1948: 30f.) and Keller (1961: 37ff.), ZG also contrasts /i~ɪ/, /y~ʏ/ and /u~ʊ/. Weber mentions minimal pairs, such as e.g. /tːyːr/ ‘expensive’ vs /tːʏːr/ ‘dry, brittle’. Schobinger (2006: 74f.) still lists both qualities, but concedes that the distinction is disappearing. Fleischer & Schmid (2006: 247) assume that they are allophonic variants.[20]

Except for schwa, which is invariably short, and [œː], which is almost exclusively long, all vowels may be long or short. The short rounded front vowel [œ] is rare.[21] Apart from a handful of words of French origin – e.g. *Petit-Beurre* [pːøtːipœːr] ‘butter biscuit’ – long [œː] exclusively appears in umlauted words. There is no corresponding non-fronted [ɔː] in contemporary ZG. As shown in (4), [œː] occurs as the umlaut variant of forms which have [ɒː] – or its unrounded free variant [ɑː] – as a stem vowel.[22]

19 This is contrary to StG, where it is assumed that vowel quantity and quality are interrelated. It is, however, not agreed upon whether the former implies the latter (e.g. Hall 1992, Wiese 1996) or vice versa (e.g. Moulton 1962, Eisenberg 2005: 35). Vennemann (1982, 1991a, 1991b) considers the distribution as the phonetic implementation of different syllable cuts (see Lenerz 2000 and Becker 2002 for discussion).

20 Short close vowels are slightly lower than their long counterparts, cf. Schmid (2004) who provides a detailed study of the vowel system of ZG.

21 From the examples given in Weber (1948) only [ʃnœrə] ‘mouth (coll.)’ and [uːfhœrə] ‘stop (inf.)’, are still in use. Fleischer & Schmid (2006: 247) report [hœrtøp͡fəl] ‘potato’ besides its – younger – variant [hɛrtøp͡fəl]. It is, however, worth noting that many ZG speakers use [œ] as a substitute for [ʌ] in English loanwords such as *curry, pub* or *brunch*.

22 Historically, ZG [ɒː] is a descendant of MHG *ā,* which underwent a rising and rounding process ā > [ɔː], sometimes dubbed “Verdumpfung” ‘dulling’. In the ZG region, [ɔː] started to disappear in the 16th century, while it is still present in neighbouring dialects as well as in the Oberland vernacular (Hotzenköcherle 1984: 31; cf. 1.2). The umlaut [œː] remained, leading to what Moulton (1967: 1402) calls “morphophonemic genesis”.

(4) [ɒːl] – [œːl] ‘eel (sg., pl.)’ [øːl] ‘oil’
[ʃpɒːtː] – [ʃpœːtːər] ‘late, later’ [roːtː] – [røːtːər] ‘red, redder’
[ʃtrɒːsː] – [ʃtrœːsːli] ‘street (sg., dim.)’ [ʃoːsː] – [ʃøːsːli] ‘apron (sg., dim.)’

The ZG diphthongs are given in Table 2:

ei̯	frei̯	‘free’	iə̯	niə̯	‘never’	pæu̯m	æu̯	‘tree’
æi̯	ʃtæi̯	‘stone’	yə̯	myə̯t	‘tired’	ou̯	sou̯	‘pig’
oi̯	noi̯	‘new’[23]	uə̯	xuə̯	‘cow’			

Table 2: ZG diphthongs (the examples are taken from Fleischer & Schmid 2006: 248, and Weber 1948: 31f.)

Phonologically, diphthongs pattern with long vowels in ZG. Evidence comes from the near-allophonic distribution of the velar fricative /x/. As shown in (5), the velar fricative surfaces as /xː/ after short vowels (a) and as /x/ after long vowels (b). Diphthongs are also followed by singleton fricatives (c).

(5) a. [pruxː] ‘fracture’ [ʃtrixː] ‘line’
b. [pruːx] ‘custom’ [riːx] ‘rich’
c. [puə̯x] ‘book’ [ʋæi̯x] ‘soft’

ZG schwa [ə] is limited to unstressed syllables. Its phonemic status is controversial.[24] However, ZG has minimal pairs suggesting that schwa has to be at least partly specified in the lexical representation:

(6) ˈɛːrɒ ‘era’ ɛːrə ‘ear (of wheat)’[25]
ˈsuːko ‘tomato sauce’ suːkə ‘suck (inf.)’
ˈʋelo ‘bicycle’ ʋelə ‘want (inf.)’

Apart from [ə], ZG has several schwa-like vowels, most prominently [i].[26] (7) gives a (non-exhaustive) overview of the contexts in which schwa-like [i] appears: first and foremost, it occurs along with schwa in inflectional morphology (a). Second, it appears

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23 Instead of [oi̯], Weber (1948: 31f.) and Keller (1941: 42) posit two diphthongs containing a rounded front vowel /øɪ/ and /œɪ/, respectively. Weber provides the examples [nøɪ̯] ‘new’ and [hœɪ̯] ‘hay’. According to Fleischer & Schmid (2006: 248), however, they “seem to have merged into a single diphthong.” My impression is that there is still some variation at the phonetic level and fronted [øi̯] is still a possible variant. I adopt the proposed transcription [oi̯]. Note, however, that nothing in the present thesis hinges on it.

24 On StG, compare e.g. Wiese (1996) who considers schwa a purely epenthetic vowel with Féry (2003, 2009, 2017) who analyses it as an allophonic variant of /e/. An overview is provided in Staffeldt (2010).

25 In their dictionaries, Weber (1961) and Gallmann (2015) list [ɛːri]. In my view, this form is outdated.

26 Two other schwa-like sounds are [u] and [e]. [u] appears when followed by /l/: næpəl – næpuˈløːs ‘mist, nebulous’; ʃpek͡xˈtɒːk͡xəl – ʃpek͡xtɒːk͡xuˈlɛːr ‘spectacle, spectacular’. The alternation is restricted to instances where the lateral precedes a vowel-initial class I affix (Siegel 1974; Kiparsky 1982b, c). [e] occurs as a linking element (so-called ‘Fugenmorphem’) between the members of a compound, e.g. *Hund*[e]*leine* ‘dog lead’, *maus*[e]*tot* ‘dead as a dodo (lit. mouse-dead)’, *Möcht*[e]*gern* ‘wannabe (lit. would-like)’ vs *Chatz*[ə]*pfoote* ‘cat’s paw’, *stund*[ə]*lang* ‘for hours (lit. hours-long)’. The exact conditions are unclear to me. However, [e] seems restricted to cases where there is no inflectional form containing [ə] in the paradigm (the plural of hunt is hynt, whereas the plural of xɒt͡s is xɒt͡sə).

as a derivational suffix in multiple functions, such as the (nowadays non-productive) deadjectival suffix (b), and as the ending for word shortenings and short names (c).[27] Third, it serves as an epenthetic vowel in inflectional forms (d).[28]

(7) a. [ə kroːsːi fræu̯] 'a tall (f.sg.nom./acc.strong infl.) woman'
b. [ʋiːtː] 'wide' [ʋiːtːi] 'width'
[høːx] 'high' [høːxi] 'height'
c. [ˈt͡sikərˌetːə] 'cigarette' [t͡siki] 'ciggy'
[ˈsuˌsɒnː] 'Susan' [susi] 'Susie'
d. [xuːrt͡s] 'short' [tə xyːrt͡siʃt] 'the shortest'
[losə] 'hear' [tu losiʃ] 'hear (2.sg.)'

2.3. Consonants

Table 3 gives an overview of the consonant inventory of ZG. A more detailed discussion is provided in the following sections.

	labial		coronal		velar	glottal
	bilabial	labio-dental	alveolar	palato-alveolar		
stops	p / pː		t / tː		k / kː	
fricatives		f / fː	s / sː	ʃ / ʃː	x / xː	
affricates	p͡f		t͡s	t͡ʃ	k͡x	
nasals	m / mː		n / nː		ŋ / ŋː	
laterals			l / lː			
trills			r			
approximants		ʋ		j		h[29]

Table 3: Zurich German consonants

[27] See Weber (1948: part V) for further functions.

[28] On the distribution of epenthetic [i], see Weber (1948: 127, 174).

[29] Ladefoged & Maddieson (1996: 137) state that glottal /h/ is more adequately categorised as a vowel. Phonologically, ZG /h/ patterns with sonorants, suggesting that it has a [+ sonorant] value (for similar analyses, see e.g. Roca & Johnson 1999; Kenstowicz 1994; Hall 2000). Evidence comes from Heusler's Law (cf. 2.4.3) that states that the contrast between singleton and geminate obstruents is only manifest in intersonorant position. If /h/ were a fricative, we would expect neutralisation. However, there is a perceptible contrast between the word-final stops in e.g. [rɒːt holə] 'to fetch the wheel' and [rɒːtː holə] 'to ask for advice (lit. fetch advice)'.

2.3.1. Obstruents

The ZG obstruent system distinguishes singletons and geminates. (Near-)minimal pairs are given in Table 4.

stops			fricatives		
p	sipə	'seven'	f	ofə	'oven'
pː	sipːə	'tribe'	fː	ofːə	'open (adj.)'
t	ʃɒtə	'damage'	s	pæsə	'broom'
tː	ʃɒtːə	'shadow'	sː	æsːə	'eat (inf.)'
			ʃ	nuːʃə	'rummage (inf.)'
			ʃː	ruːʃːə	'whoosh (inf.)'
k	pokə	'arch'	x	mɒxə	'make (inf.)'
kː	ekːə	'corner'	xː	lɒxːə	'laugh (inf.)'

Table 4: Zurich German obstruents

Table 4 shows singleton/geminate pairings for each place of articulation. Their functional load, however, varies. In particular, the distribution of fricative singletons and geminates is restricted.

Singleton and geminate stops occur word-medially, word-finally, as well as word-initially.[30] Table 5 provides (near-)minimal pairs for each position within the word.

		p	pː	
initial		**p**ɒːr	**pː**ɒːr	'bar', 'pair'
medial	V_	si**p**ə	si**pː**ə	'seven', 'tribe'
	Vː_	huː**p**ə	huː**pː**ə	'hood', 'honk (inf.)'
final	V_	ʃɒ**p**	ʃlɒ**pː**	'scratch (imp.sg.)', 'flabby'
	Vː_	tːrɒː**p**	pːiː**pː**	'trot', 'beep'

30 Kraehenmann (2001) and Lahiri & Kraehenmann (2004) suggest that the singleton/geminate contrast in word-initial position resulted from the restructuring of a former voicing opposition. They argue that the OHG consonant shift reduced Old Alemannic to a single series of voiceless stops, with one exception. Despirantisation of Þ > d led to a contrast which had to be maintained. According to Lahiri & Kraehenmann (2004) the contrast was realised as a quantity contrast. Since the former fricative Þ also appears word-initially, the quantity contrast was extended to initial contexts. As a consequence, word-initial geminate stops became permissible in the phonology of Old Alemannic, opening up the possibility for the other places of articulation. This option was exploited to integrate initial voicing contrasts of loan words. The voicing contrast of the donor language is thus reinterpreted as a length contrast, e.g. [b]*allast* → /paˈlaʃt/ 'burden' [p]*alast* → /pːaˈlaʃt/ 'palace' (Kraehenmann 2001: 139). Such an analysis is in line with the evolutionary approach taken by Blevins (2004: 170f., 2008). Blevins proposes seven "general pathways" for the evolution of geminates, one of which is reinterpretation of an obstruent voicing contrast.

		t	tː	
initial		**t**ɒŋk͡x	**tː**ɒŋk͡x	‘thank’, ‘tank’
medial	V_	ʃɒ**t**ə	ʃɒ**tː**ə	‘damage’, ‘shadow’
	Vː_	liː**t**ə	ʃtriː**tː**ə	‘suffer (inf.)’, ‘argue (inf.)’
final	V_	re**t**	re**tː**	‘talk (imp.sg.)’, ‘save (imp.sg.)’
	Vː_	rɒː**t**	rɒː**tː**	‘wheel’, ‘advice’

		k	kː	
initial		**k**oːli	**kː**okːi	‘goalkeeper’, ‘Coke’
medial	V_	po**k**ə	klo**kː**ə	‘arch’, ‘bell’
	Vː_	fiː**k**ə	hɒː**kː**ə	‘fig’, ‘hook’
final	V_	sæ**k**	ʃnæ**kː**	‘say (imp.sg.)’, ‘snail’
	Vː_	hɒː**k**	pøː**kː**	‘fence’, ‘bogey’

Table 5: Zurich German stops in initial, medial and final word position

It can be seen from the examples in Table 1 that the distribution of singleton and geminate stops is independent of the length of the preceding vowel. Long and short vowels combine freely with singleton and geminate stops in ZG.[31]

There are no wordinitial velar geminates in the native vocabulary. Native words with initial /kː/ are the result of total assimilation and thus morphologically complex (cf. 2.4.1).[32] The gap originates from the OHG consonant shift where Germanic **k* became /k͡x/ in High Alemannic. It developed further to /x/ word-initially, e.g. [xɒltː] ‘cold’. Recent borrowings from StG are pronounced with the characteristic Swiss affricate /k͡x/: [k͡xlɒːr] ‘clear’, [k͡xompːliˈmæntː] ‘compliment’. ZG [k͡x] thus synchronically corresponds to aspirated [kʰ] in StG.[33]

31 In this respect, ZG differs from several closely related varieties, including the standard language. StG permits neither (true) geminate consonants nor short vowels in open stressed syllables. As has famously been described by Paul (1884), a process of lengthening of open syllables has affected a vast area of the German speaking territory. It was partly accompanied by a further process of degemination. The resulting isochrony is reflected in closely related dialects. See Naiditsch & Kusmenko (1992) and Seiler (2005a) on Bavarian. For a comprehensive overview of the quantity developments in the phonology of German dialects see Seiler (2009) and Goblirsch (2018). Traits of isochrony are also found in ZG, cf. 2.3.1 and 2.3.2 on the fricatives and the sonorants, respectively.

32 Words with initial /kː/ are common, but are usually morphologically complex, e.g. /kːrympːəl/ ‘junk’, [kːmyə̯s] ‘vegetables’, [kːlumpː] ‘trinkets’, [kːrixt] ‘court’, all of which contain the prefix *kː-*. However, initial velar geminates regularly occur in borrowings, especially from Italian, such as in [kːɑneˈloːni] ‘Cannelloni’, [kːjɑntːi] ‘Chianti’. We even find minimal pairs such as [kotːi] ‘godmother’ vs [kːotːi] ‘Cotti (last name of a former Swiss minister from Italian-speaking Switzerland)’.

33 The loans are not necessarily of German origin, but I assume that came into ZG via the (written) standard language. The same happens to borrowings from English, e.g. [k͡xompːjuːtːər] ‘computer’, [k͡xuːl] ‘cool, great’. Given the regularity of the affrication process, Baur (1983: 24f.) considers it a sound law. More than a century earlier, Winteler (1876: 57) described the

Turning to the fricatives, the examples in Table 6 show that the contrast is present in word-medial and word-final position. In contrast to stops, geminate fricatives do not occur word-initially.[34]

		f	fː	
medial	V_	ofə	ofːə	‘oven’, ‘open (adj.)’
	Vː_	ʃnuːfə	suːfːə	‘breathe (inf.)’, ‘booze (inf.)’
final	V_	uf	tːøfː	‘on (prep.)’, ‘motorcycle’
	Vː_	krɒːf	ʃɒːfː	‘duke’, ‘sheep’

		s	sː	
medial	V_	pæsə	æsːə	‘broom’, ‘eat (inf.)’
	Vː_	soːsə	ʃtoːsːə	‘sauce’, ‘push (inf.)’
final	V_	pis	pisː	‘until’, ‘bite’
	Vː_	krɒːs	kroːsː	‘grass, ‘tall’

		ʃ	ʃː	
medial	V_	pːiʃi	tːuʃːi	‘pyjamas (sg.)’, ‘shower’
	Vː_	nuːʃə	ruːʃːə	‘rummage (inf.)’, ‘whoosh (inf.)’
final	V_	piʃ	tːiʃː	‘are (2.sg.)’, ‘table’
	Vː_	kːnuːʃ	tːuːʃː	‘mess’, ‘exchange’

relation between the aspirated velar stop and the velar affricate in similar terms. Consequently, the geminate is chosen if the loan comes from a donor language that does not have aspirated stops as e.g. Italian or French. As for voiced /g/ (which Baur does not discuss), ZG chooses the singleton, e.g. [klɒsːe] ‘ice cream’ from French *glace*.

34 Kraehenmann (1996) assumes initial fricative geminates for Thurgovian. In subsequent work, however, Kraehenmann (2003: 55) states that only stops have a “quantity contrast in all word positions”. Surprisingly, her word list nevertheless contains various items she (2003: 249) claims to have word-initial geminates. The corresponding words have initial singletons in ZG. Word-initial fricative geminates only occur in sandhi contexts: [sːɒlt͡s] < s sɒlt͡s ‘the salt’, Heusler (1888: 9) mentions *s Sophie* [sːofːi] ‘the (n.) Sophie’. Additionally, they are sometimes used as a means of emphasis. Weber (1948: 39) mentions exclamations such as [ʃːæmː ti] ‘shame on you!’ and [lːuə̯k æ tɒː] ‘look at that!’. See also Heusler (1888: 11) for similar observations on Basle German. Gemination is not uncommon in this function in the world’s languages. Blevins (2004: 170ff.) identifies expressive (emphatic) lengthening as one of the pathways for the evolution of length in the world’s languages. Kim (1965: 353f.) reports it for Korean, where it seems to be a regular part of the morphology. In ZG, gemination under emphasis is completely *ad hoc.* It is noteworthy, however, that geminate initial fricatives do occur in ethnolectal ZG: [jɒː fːol iŋ fːɒl] ‘yeah, fully the case’ (Schmid 2012: 70).

		x	xː	
medial	V_	mɒxə	lɒxːə	‘make (inf.)’, ‘laugh (inf.)’
	Vː_	pruːxə	rɛːxːə	‘need (inf.)’, ‘retaliate (inf.)’
final	V_	mɒx	lɒxː	‘make (imp.sg.)’, ‘laugh (imp.sg.)’
	Vː_	pruːx	rɒːxː	‘custom’, ‘revenge’

Table 6: Zurich German fricatives in word-medial and word-final position

In the labial and alveolar series, singletons and geminates clearly contrast.[35] This is different for the palatal and the velar series. Keller (1961: 47) considers [ʃ] and [ʃː] allophones, the former occurring initially and the latter – disregarding a few loanwords – elsewhere. Likewise, Weber (1948: 80) states that all medial and final palatal fricatives are *fortis* unless they are of French origin.[36] Examples are given in (8) where French [ʒ] is integrated as a voiceless singleton [ʃ] in ZG.

(8) [kɒrɒːʃ] ‘garage’
[loːʃə] ‘loge’
[ɒrɒŋʃiə̯rə] ‘arrange’

Velar fricatives are in near-complementary distribution: geminates occur after short vowels, and singletons after long vowels. Items such as [mɒx] and [rɒːxː] from Table 6 are exceptions.[37]

Let us finally turn to the affricates. According to Weber (1948: 25), ZG has four affricates. As shown in Table 7, they occur in all positions of the word.[38]

35 I will address the issue why word-final singletons after short vowels are almost exclusively forms of verbal inflection in 4.3.1.

36 Weber (1948: 80) additionally mentions singleton [ʃ] as a result from assimilation of /s/, particularly in /sʋ/ clusters. They are quite frequent in place names, e.g. Adli[ʃ]wil.

37 Keller (1961: 47) regards the singleton in [mɒxə] as a “free variant”, preferred by “the younger generation”. He furthermore stresses the exceptional character of [ksɛx] and [kʃɛx], the subjunctive forms of [kseː] ‘see’ and [kʃeː] ‘happen’, respectively. In addition, Weber (1948: 80f.) mentions a few past participle forms such as [kʃlixə] from [ʃliːxə] ‘sneak’ and [kxroxə] from [xryːxə] ‘creep’. He suggests that the unexpected short fricative was influenced by the infinitive. Casual inquiry among friends revealed that no one was familiar with the levelling pattern illustrated in Weber. Some of them even rejected it as ungrammatical or “not Zurich German”. The isochrony (long vowel + short consonant vs short vowel + long consonant) thus seems to be very stable. Most velar fricatives in ZG originate from Germanic *k > xx. In contrast to the labial and coronal series, they underwent degemination after long vowels, compare e.g. [pɒxːə] ‘bake (inf.)’, [ʋuxːə] ‘week’, [pæxːər] ‘beaker’ with [ʃprɒːx] ‘language’, [pruːx] ‘custom’, [ræu̯xə] ‘smoke (inf.), [puə̯x] ‘book’, [puːx] ‘belly’. The singleton in /mɒxə/ is therefore unexpected both diachronically and synchronically. A comparable example is [ʋuxər] ‘profiteering’. Again, this seems to be a new variant, Weber & Bächtold (1961) list [ʋuə̯xər]. Apart from the above-mentioned [rɒːxː], we find a very limited number of words, where the original geminate is retained, all containing the low vowel [ɒ]: [prɒːxː] ‘fallow’, [ʃmɒːxː] ‘dishonour’. In the latter case, however, the fricative probably is of Germanic origin, although the etymology is not entirely clear (cf. Kluge 1995). Otherwise, Germanic **h* [x] occurs almost exclusively after long vowels. Examples are [ʃyːx] ‘shy’, [nœːx] ‘near’, [ʃluːx], ‘hose’, [t͡sɛːx] ‘tough’. The only counter-example I am aware of is [lɒxːə] ‘laugh’ (where the geminate is etymological, cf. Braune & Reiffenstein 2007: 145). A possible candidate for a short Germanic velar preceded by a short vowel is [tox] ‘yes, but’. In my intuition as a native speaker, the length of the obstruent depends on the position in the sentence (see also 4.3.1).

38 Ham (1998) suggests a distinction between singleton and geminate affricates for Bernese. There is no evidence to posit two series for ZG.

	labial	alveolar	palatal	velar
	p͡f	t͡s	t͡ʃ	k͡x
initial	p͡funt 'pound'	t͡siːtː 'time'	t͡ʃoːpːə 'jacket'	k͡xɒfi 'coffee'
medial	tːɒp͡fər 'brave'	ʃlet͡sə 'slam (inf.)'	tːyt͡ʃə 'bump (inf.)'	tːæŋk͡xə 'think (inf.)'
final	xop͡f 'head'	xɒt͡s 'cat'	tːot͡ʃ 'idiot'	ʃpæk͡x 'bacon'

Table 7: Zurich German affricates

It is a matter of controversy whether homorganic stop + fricative sequences are monophonemic units or clusters. Keller (1960: 45) advocates the latter without offering an explanation. However, I assume that ZG has affricates. Like the fricatives, they occur at four places of articulation.[39]

The main argument for a monosegmental analysis for affricates comes from templatic considerations. For simplex words, ZG allows a limited amount of positions within the syllable. (9)a) is grammatical, while the example in (b) is ill-formed. Affricates, however, are allowed after long vowels or vowel + sonorant sequences (c).[40]

(9) a. hɒlm 'straw'
sæmf 'mustard'
b. *hɒːlm
*sæːmf
c. xrɒmp͡f 'drudgery'
ʃtump͡f 'blunt'
xrɒŋk͡x 'ill'

2.3.2. Sonorant consonants

ZG has the following sonorant consonants, shown in Table 8:

	bilabial	alveolar	velar
nasals	m / mː	n / nː	ŋ / ŋː
laterals		l / lː	
trills		r	

Table 8: Zurich German sonorant consonants

39 Apart from post-alveolar /t͡ʃ/, affricates are the result of the High German consonant shift. /t͡ʃ/ has emerged later. Stucki (1921: 51) notes that it is more frequent in SwG dialects than in the standard language. His examples suggest an onomatopoetic component. We find a number of nouns, all of which roughly mean "silly and stupid person", such as [t͡ʃoːli], [t͡ʃumpːəl], [t͡ʃɒlpːi]. Additionally, the affricate is common in verbs denoting a clapping sound: [præt͡ʃə] 'strike', [tːæt͡ʃə] 'bang', [tːyt͡ʃə] 'bump' (see also Weber 1948: 369f.).

40 Strictly speaking, matters are somewhat more complex. Minimality effects indicate that affricates are geminates (cf. 4.3.1). I will not pursue the issue any further as it seems immaterial to the present discussion. To my knowledge, little work has been done on SwG affricates. Among the few studies are Dieth & Brunner (1943), Ham (1998) and Stäheli Toualbia (2005).

An overview of the distribution of ZG sonorants is given in Table 9. The examples are drawn from Stucki (1921), Weber (1948) and Weber & Bächtold (1961).

		m	**mː**	**n**	**nː**	**ŋ**	**ŋː**
initial	#_V	**m**æːl 'flour'		**n**ɒmə 'name'			
medial	V_V	ʃʊy**m**ə 'swim (inf.)'		pru**n**ə 'fountain'		hɒ**ŋ**ə 'hang (inf.)'	
	Vː_V	ʃuː**m**ə 'foam (inf.)'		fɒː**n**ə 'flag'			
final	V_#		ʃli**mː** 'terrible'		tːy**nː** 'thin'		hɒ**ŋː** 'slope'
	Vː_#	ʃliː**m** 'slime'		ʃøː**n** 'beautiful'		kiə**ŋ** 'go (3.sg.sbjv)'	

		l	**lː**	**r**
initial	#_V	**l**iːm 'glue'		**r**olə 'role'
medial	V_V	t͡se**l**ə 'count (inf.)'		xɒ**r**ə 'car'
	Vː_V	hyː**l**ə 'cry (inf.)'		fɒː**r**ə 'drive (inf.)'
final	V_#		ʃti**lː** 'quiet'	
	Vː_#	mæː**l** 'flour'		tːyː**r** 'door'

Table 9: Distribution of Zurich German sonorant consonants

Although grammars recognise that ZG has phonetically long and short sonorants, they deny them phonemic status.[41] As can be seen from Table 9, /r/ is the sole sonorant that has no long counterpart, an issue I will return to in 2.3.2.3. Since the velar nasal /ŋ/ has a limited distribution, it is addressed separately in 2.3.2.2. Table 9 suggests that the word-final sonorants /n/, /m/ and /l/ are in complementary distribution: they are always short word-medially, while in word-final position they are short only when they follow a long vowel. When preceded by a short vowel, they are long.

In the next section, I will discuss the distribution of the sonorants in more detail. Contrary to the prevailing view that sonorants have no length contrast, I will show that singleton and geminate sonorants have at least some contrastive power. These observations contradict earlier descriptions that assume a complementary distribution.

[41] See Keller (1961: 47): "Fortis and lenis occur in complementary, i.e. mutually exclusive, positions in the case of the … sonants /m, n, ŋ, l/. The difference is therefore not phonemically relevant." The same observation is made by Heusler (1888: 8).

2.3.2.1. Distribution of singleton and geminate /n/, /m/, and /l/

The general assumption is that the distribution of long nasals and laterals is predictable. Weber (1948: 35, 39) notes that /m/, /n/, /ŋ/ and /l/ have long and short exponents in word-final position. He is not particularly explicit about word-final sonorants but mentions that nasal sonorants as well as /l/ are strengthened [“verstärkt”] and deviate [“abweichen”] after short vowels. Baur (1974: 14) reports that *lenis* consonants are slightly fortified [“leicht fortisiert”] after short vowels. The examples in (10) illustrate this. Word-final sonorants are long after short vowels (a), and short after long vowels (b). Word-medially, the sonorant is always short, regardless of whether it is preceded by a short (c) or a long (d) vowel.

(10) a. [pɒnː] ‘ban’ b. [pɒːn] ‘train’
[lɒmː] ‘lamb’ [lɒːm] ‘lame’
[ʃtɒlː] ‘barn’ [ʃtɒːl] ‘steel’

c. [ʋɒnə] ‘tub’ d. [poːnə] ‘bean’
[nɒmə] ‘name’ [prɛːmə] ‘horsefly’
[rolə] ‘role’ [foːlə] ‘foal’

In contrast to the obstruents, where any combination is permissible, vowel length and consonant length are interdependent for the sonorants. Tautosyllabic sequences of short vowel + long consonant, and long vowel + short consonant are in complementary distribution. Given that vowel length is contrastive for independent reasons, the most plausible assumption seems to be that vowel length is lexical, while sonorant length is allophonic.

Sonorant length is dependent on the position in the syllable, which leads to paradigmatic alternations. The examples in (11), taken from Weber (1948: 39, 223), illustrate this. While the stem-final sonorant is long in word-final position (a), it is short when it precedes a vowel-initial inflectional ending (b). Alternation also occurs at the word boundary: when followed by a vowel-initial word, the preceding sonorant is short (c).

(11) a. [fərˈt͡selː] ‘tell (imp.sg.)’
[holː] ‘fetch (imp.sg.)’
[tːumː] ‘stupid’
b. [fərˈt͡selə] ‘tell (inf.)’
[ən tːumə] ‘a stupid’
[tɒs iʃ tymər] ‘this is more stupid (comp.)’
c. [hol ən ɒntərə] ‘fetch (imp.sg.) someone else’

Schobinger (2008: 87) does not explicitly refer to the length of the preceding vowel, but his examples point in that direction, cf. (12):

(12)	a.	[fɒlə] ‘fall (inf.)’	[fɒlː] ‘fall (imp.sg.)’
	b.	[tːymi] ‘stupidity’	[tːumː] ‘stupid’
	c.	[tːynər] ‘thinner’	[tːynː] ‘thin’

The distribution presented so far, however, does not provide a sufficiently accurate description of contemporary ZG. In fact, we do find word-medial long sonorants in two areas. First, sonorants in adjectives do not exhibit paradigmatic alternation the way described in Weber. This suggests that some of the examples in (11) and (12) are outdated. Second, a somewhat idiosyncratic lengthening rule before *-ər* has entered the phonological system. I will address the two cases in turn.[42]

While there is ample evidence for the short-long alternation in the verbal paradigm, the situation of (12)b) and (c) is less straightforward. As far as adjective inflection is concerned, measurements on sonorant duration in this study reveal differences among the informants. The right column in (13) shows the corresponding sentences from my corpus.

(13)	a.	[folː] ‘full’	b.	en [folːə] Buuch ‘a full belly’
		[ʃlimː] ‘terrible’		en [ʃlimːə] Fëëler ‘a terrible mistake’
		[tːynː] ‘thin’		e [tːynːi] Wand ‘a thin wall’

Fig. 5 provides the results of the 8 speakers.[43] The second column corresponds to (13)b). It shows the duration of the targeted sonorants in inflected adjectival forms. They are contrasted with word-medial sonorants in simplex words as in (10)c).

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[42] A possible third area are some non-native nouns. They all end in a full vowel in the singular where the medial sonorant is a geminate, e.g. [ʋilːɒ] ‘villa’, [pːikːoˈpelːo] ‘shipshape’, [koˈrilːɒ] ‘gorilla’. The geminate pronunciation may in some cases reflect the pronunciation of the donor language, in other cases it be a spelling pronunciation. As for the latter, however, there are examples where the sonorant is short despite the written form: [ɒˈpːolo] ‘Apollo’, [pːuli] ‘Pullover’, [hɒlo] ‘hello’.

[43] Due to the sparse data, the measurements presented here must be regarded as preliminary. They are not representative and are not included in the statistical analysis (see Chapter 6).

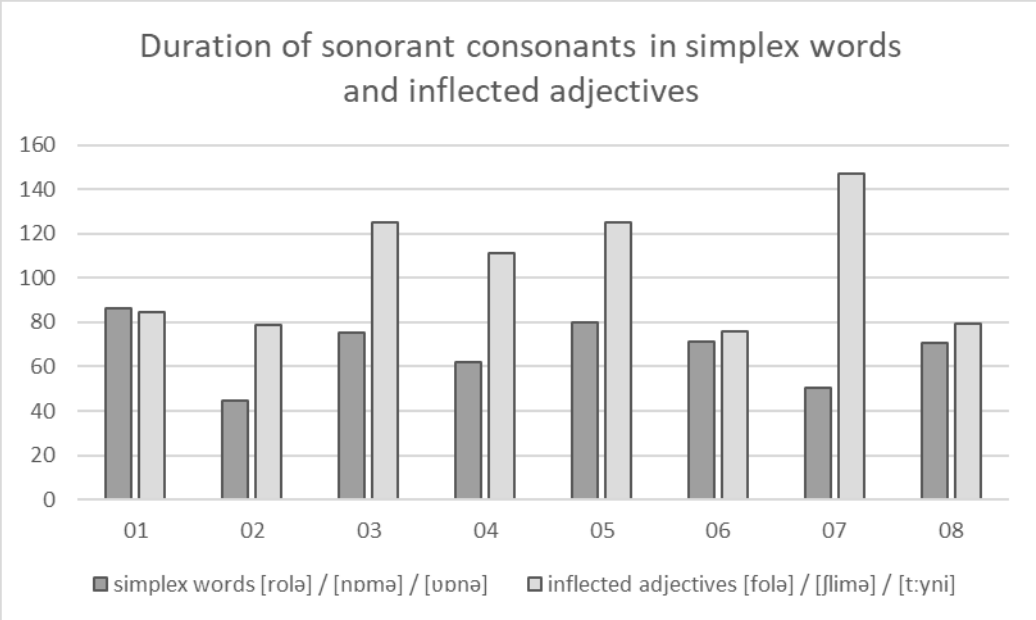

Fig. 5: Duration (in ms) of sonorant consonants: simplex words and inflected adjectives (n = 47; 1 missing: speaker 05 has [folnə])

From Fig. 5 we can see that 5 of 8 speakers distinguish between word-medial sonorants in simplex words and those in inflected forms.[44] In all five cases, the target sonorant is longer in the inflected form. Weber (1948: 37ff.) does not report such cases. Rather, he gives *en tume* 'a stupid', *en tüne* 'a thin' as examples of what he calls a "zürcherische Eigentümlichkeit [a peculiarity of ZG]".[45] This suggests that ZG underwent recent changes that affected the adjectival paradigm. The fact that stem-final sonorants remain long in adjective inflection even leads to minimal pairs:

(14) a. [t:olə] 'gully'
 b. [t:ol:ə] 'great (m.pos.strong infl.)'

Minimal pairs as in (14) are rare. The adjectives *voll* 'full' and *still* 'quiet' in (15) show alternations between the attributive (inflected) adjective (a), and the predicative (uninflected) form (b):

(15) a. en [fol:ə] Buuch 'a full belly'
 en [ʃtil:ə] Bueb 'a quiet boy'
 b. de Buuch isch [folə] 'the belly is full'
 sötsch [ʃtilə] sii 'you should (2.sg.) be quiet'[46]

[44] The data is, again, sparse, as I have only one entry for each pair per place of articulation and per speaker (one missing).

[45] Word-medial short sonorants in ZG are indeed "peculiar" in that they are an innovation. Most of them developed from MHG geminates (cf. Paul 2007: 148ff.; Christen et al. 2015: 273).

[46] The form of the predicative adjective reflects agreement, but is now fossilised and uninflectable (cf. Weber 1948: 126).

Word-medial long sonorants are restricted to adjectives. Verbs (16)a) and nouns (b) have short sonorants in their inflected forms.

(16)	a.	[fərˈt͡selː] 'tell (imp.sg.)'	[fərˈt͡selə] 'tell (inf.)'
		[ʃʊymː] 'swim (imp.sg.)'	[ʃʊymə] 'swim (inf.)'
	b.	[ʃtimː] 'voice'	[ʃtimə] 'voices'
		[finː] 'Finn'	[finə] 'Finns'

An in-depth analysis of the historical development would certainly be beyond the goals pursued here. I assume that the historical length distinction and the more recent requirement of minimal (bimoraic) words – see 2.4.5 and 4.3.1 on Monosyllabic Lengthening – led to a situation of isochrony that was ultimately interpreted as complementary distribution.

Monosyllabic words that had a short vowel and ended in a short sonorant in Middle High German were lengthened to meet the minimality requirements of ZG. There are two ways to do this, either by lengthening the vowel (17)a) or the consonant (b). As for MHG words that ended in a geminate, the vowel remained short (c).[47]

(17)	a.	MHG *tal*	>	ZG [tːɒːl] 'valley'
		MHG *spil*	>	ZG [ʃpiːl] 'game'
	b.	MHG *vil*	>	ZG [filː] 'many'
	c.	MHG *stille*	>	ZG [ʃtilː] 'quiet'
		MHG *stall*	>	ZG [ʃtɒlː] 'stable'

As a consequence, tautosyllabic short sonorants are always preceded by long vowels, be they etymologically long (as in MGH *schûm* 'foam') or lengthened (as in (17)a).[48] Similarly, monosyllabic words that retained the short vowel ended in a geminate sonorant, again either underlyingly (c) or as the result of Monosyllabic Lengthening (b). This led to a situation of "analytic ambiguity" (Yu 2011: 1911), where short and long sonorants no longer appeared in the same context in monosyllabic words. While vowel length was interpreted as underlying, the distribution of short and long sonorants was reinterpreted as allophonic variation. Alternations in the paradigm like those reported in Weber – cf. (11) – reflect this.

Heusler (1888: 14) follows a similar line of reasoning when he states that the requirement that long vowels precede *lenis* sonorants and short vowels precede *fortis*

[47] The examples are from Stucki (1921: 27ff; 59ff.); see also Winteler (1876: 68f.) for a similar argument.

[48] Word-medially after short vowels, sonorant singletons and geminates were contrastive in MHG (cf. Paul 2007: 141ff.). The contrast also applied to /r/ (Paul notes MHG *schër(en)* 'shear (inf.)' vs *schërren* 'scratch (inf.)').

sonorants may proceed in "various directions [nach verschiedner Richtung]". In his view, vowel lengthening is the predominant direction.[49]

The lengthening of word-medial sonorants is restricted to adjectives. There is no evidence that it reflects a general change of lengthening processes, for example due to language contact. Rather, it appears that in the course of the last few decades, adjectival forms removed the long-short alternation in order to achieve paradigm uniformity (Kiparsky 1982a, c). The lengthening rule, which is usually restricted to coda sonorants "overapplies" (Albright 2011) to intervocalic contexts.[50]

As a result of the levelling within the adjectival paradigm, the distribution of long and short sonorant consonants becomes less predictable. From an acquisitional viewpoint, this makes it more difficult to assess the relation between short and long sonorants. It remains to be seen how the phonological system responds to these changes. The fact that the distribution is no longer entirely governed by phonological rules may lead to a categorical reinterpretation of the (previously allophonic) status of singleton and geminate sonorants.

The second area where word-medial sonorants are long involves words ending in *-ər* (and to a lesser extent also *-əl*). Again, this seems to be a recent development. The *Sprachatlas der deutschen Schweiz* (SDS), the linguistic atlas of the German-speaking part of Switzerland, registers predominantly short sonorants in the ZG area.[51]

While Weber (1948: 36ff.) notes [himəl] 'heaven' and [sumər] 'summer', Schobinger (2008: 87) explicitly mentions lengthening before *-ər:* "It seems, however, that *l, m,* and

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49 Orig.: "Dabei hat die Ausgleichung zu Gunsten der Vocaldehnung überwogen."

50 As usual when dealing with lexical changes, we cannot provide a conclusive explanation why levelling occurred in (and only in) the adjectival paradigm. However, from a learner's perspective, one could argue that uninflected adjectives are very frequent in ZG. Not only do they occur in adverbial and predicative function, but also in attributive contexts (Weber 1948: 121f.). Furthermore, many derivational suffixes as well as the superlative ending *-ʃtə* are consonant-initial, thus leaving the sonorant in question in the coda position. As for nouns, only few monosyllabic nouns ending in a sonorant consonant have disyllabic forms in the nominal paradigm. Most of them remain monosyllabic and use umlaut as the plural marker, e.g. [k͡xnɒlː] – [k͡xnælː] 'bang – bangs', others are uncountable nouns, e.g. [ʃlɒmː] 'mud', [pɒnː] 'ban'. Disyllabic forms occur when the plural ending is *-ə* or *-ər.* The latter only occurs with some neuter nouns. As will be discussed momentarily, *-ər* triggers lengthening and thus interferes with the onset-coda alternation (e.g. [muːl] – [myːlːər] 'mouth – mouths') on independent grounds. The plural ending *-ə* is attached mostly to feminine nouns. Here, we find a handful of cases where alternating forms still occur, cf. (16).

51 The SDS (1965) contains linguistic maps based on questionnaires. They were distributed between 1939 and 1957 to elderly informants. The maps of interest here are: Nos 186 *Tane* 'fir tree', 187 *Hame* 'ham', 188 *Himel* 'sky', 189 *Sumer* 'summer', 191 *Zimermaa* 'carpenter' 195 *chliiner,* 'smaller'*,* 196 *Jäner* 'January', 197 *Chele* 'ladle', 198 *Teler* 'plate'. Note that the geminate is rather wide-spread for 'summer' (map 189). Ruch (2015) proposes that the prevailing pronunciation in the two largest cities of the Canton (Zurich and Winterthur) has influenced the entire area.

n lengthen when -*ər* follows directly after the stressed syllable.”[52] Measurements conducted in Ruch (2015) also found that intervocalic sonorants usually have short durations, but they are long when followed by -*ər*.

Compared to word-medial sonorants that do not end in -*ər,* the sonorants in (18) are thus expected to be longer.

(18) [tːunːər] ‘thunder’
[t͡simːər] ‘room’
[xælːər] ‘cellar’

My measurements corroborate this assumption. The right column shows sonorants that precede -*ər.* Compared to the word-medial sonorants followed by simple schwa – cf. (10)c) –, they are considerably longer.

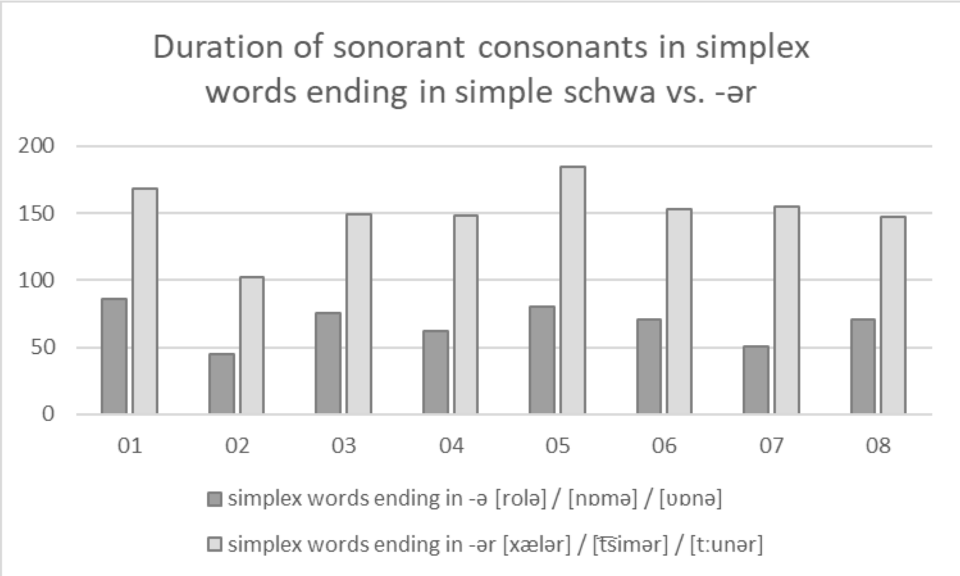

Fig. 6: Duration (in ms) of sonorants in simplex words ending in -*ə vs* -*ər* (n = 48)

Lengthening of the sonorants before -*ər* is not restricted to simplex words. It also occurs when -*ər* is a suffix, regardless of its morphological function. As shown in (19), -*ər* is used for comparison (a), the formation of agent nouns (b), and plural formation (c). Some speakers also lengthen after long vowels (c) and diphthongs (d). Stems ending in /r/ are excluded from lengthening (e):[53]

[52] Orig.: “S schiint aber, das sich *l / m / n* verlengered, wän es *-er* grad nach de betoonte silbe chunt.” On the lengthening effect of -*ər* see also Dieth & Brunner (1943: 752).

[53] (19)a) and (d) are from Schobinger (2008: 87). He also notes [fluːmːər] ‘duster’ (from [fluːm] ‘fluff’) and [fɛːlːər] ‘mistake’ (from [fɛːlːə] ‘err (inf.)’) as examples where gemination is triggered even after long vowels. Further support comes from the ZG rhyming dictionary (Walter 2004), where *Zimmer* ‘room’ rhymes with *schlimmer* ‘worse’, and *Chäller* ‘cellar’ with *gschnäller* ‘faster’.

(19) a. [tːynː] ‘thin’ [tːynːər] ‘thinner’
b. [ʃʋymə] ‘swim (inf.)’ [ʃʋymːər] ‘swimmer’
[rænə] ‘run (inf.)’ [rænːər] ‘fast-seller’
[prylə] ‘cry (inf.)’ [prylːər] ‘last cry’
c. [muːl] ‘mouth’ [myːlːər] ‘mouths’
[ʃliːm] ‘slime’ [ʃliːmːər] ‘sycophant’
d. [ʃpyə̯lə] ‘rinse (inf.)’ [ˈkʃiːrˌʃpyə̯lːər] ‘dishwasher’
[huə̯n] ‘chicken’ [hyə̯nːər] ‘chickens’
e. [porə] ‘drill (inf.)’ [porər] ‘drill’
[muːrə] ‘lay bricks’ [muːrər] ‘bricklayer’

Weber (1948: 37f.) attributes such cases to the influence of neighbouring dialects. However, dialect contact does not adequately capture the phenomenon. Consider the map for StG *Tanne* ‘fir tree’ in Fig. 7, from the *Kleiner Sprachatlas der deutschen Schweiz (KSDS).*[54] It shows that the sonorant is long in neighbouring dialects in the West, but short in ZG. Thus, language contact does not satisfactorily explain why ZG permits long sonorants in the above-mentioned cases only.

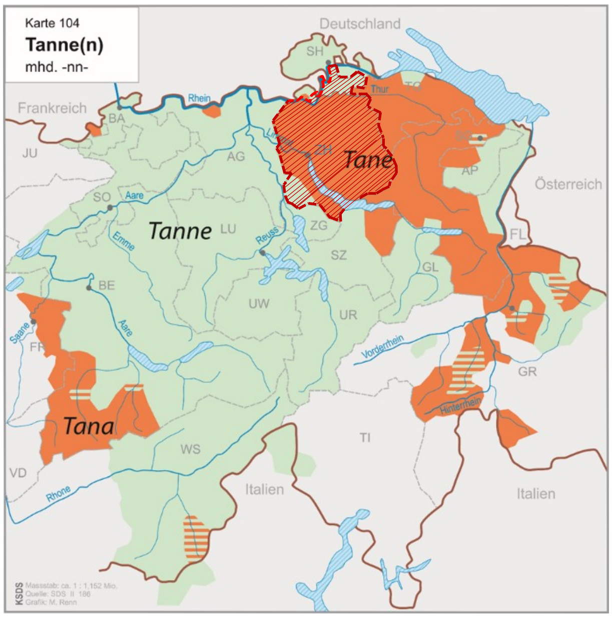

Fig. 7: Dialect map for the distribution of word-medial short vs long sonorants in the simplex word *Tanne* ‘fir tree’ (KSDS, map No 104; the hatched area [added by KW] marks the Canton of Zurich)

While *-ər* obviously triggers lengthening, an explanation is still outstanding. The process is in any case context-sensitive and affects only nasals and the lateral when they precede *-ər,* and *-əl,* respectively. Obstruents are not affected. In (20), the stem-final obstruent /p/ does not alter in agent noun formation, hence (bii) is ill-formed. This indicates that obstruents – contrary to sonorant consonants – have an underlying

[54] See also SDS (1965), map 186.

singleton/geminate contrast, which blocks lengthening in the very environment in order to maintain the lexical contrast.[55]

(20) a. [ʃtrepə] 'strive (inf.)'
bi. [ʃtrepər] 'striver' bii. *[ʃtrepːər]

The fact that only verbs and nouns have paradigmatic alternations, while adjectives increasingly retain the long sonorants in the inflectional forms, may indicate that (at least for some speakers) the length of the stem-final sonorant is lexical.[56] The lengthening power of *-ər* may have aided this development, as the suffix *-ər* is also used for comparative formation. The growing role of the written language and contact with neighbouring dialects probably further influenced the development (cf. Fleischer & Schmid 2006: 246).

2.3.2.2. The velar nasal

Velar nasals only occur in word-medial or word-final position. According to Weber (1948: 35, 39) and Keller (1961: 47f.), the velar nasal is short intervocalically. It is long tautosyllabically when it is preceded by a short stressed vowel. Fleischer & Schmid (2006: 246) give [ʃtɒŋə] 'pole' as an example. They mention lengthening when [ŋ] is followed by *-ər,* e.g. [leŋːər].[57]

Contrary to the above statements, velar nasals in today's ZG appear to be invariably long. The data in my corpus did not confirm the complementary distribution discussed in 2.3.2.1. Rather, they indicate Weber's "ZG peculiarity" of short sonorants regarding

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55 Lengthening (or: fortition) before *-ər* seems to be well-documented in historical linguistics, too. It sometimes also affected stops (see Paul 2007: 82ff., 130).

56 There is some indication that the geminate pronunciation is also retained in word formation. My impression is that there is some fluctuation with adjectives, e.g. [ʃnælː] 'fast' → [ʃnæl(ː)ik͡xæi̯tː] 'velocity', [helː] 'bright' → [hel(ː)ik͡xæi̯tː] 'brightness' vs [ʃʊɒmː] 'sponge' → [ʃʊɒmik] 'vague (lit. spongy)' or [ʃæmə] 'be ashamed (inf.)' → [kːʃæmik] 'shameful'. This again speaks in favour of an analysis that treats final sonorants in adjectives as underlyingly long. Further research is needed to determine how the singleton/geminate contrast relates to the word class and to morphological processes.

57 The standard analysis is that velar nasals are underlyingly clusters consisting of an unspecified nasal and a velar stop /Nk/ (see e.g. Vennemann 1970; Dressler 1981; Hall 1992; Wiese 1996; Féry 2003 on German, a somewhat different approach is by Kager & Zonneveld 1986 for Dutch). On the one hand, such an analysis accounts for the non-occurrence of initial [ŋ], since nasal + stop sequences are illicit onsets. On the other, the it accounts for the restriction of velar nasals to positions after short vowels. Both limitations can be observed for ZG, too. However, although rare, velar nasals after long vowels are attested. Five of my informants had ŋ after long vowel for the 3rd person subjunctive of the verb *gaa* 'go': Four of them said *gieng* [kiəŋ], which is considered the correct form by Weber (1948: 253) and Schobinger (2007: 42). One speaker said [kiəŋti]. The average duration was 173 ms, ranging between 157 and 212 ms, suggesting a long consonant. The forms used by the other informants were [kiəxt] [køxt] [kɛxti] – demonstrating the dazzling diversity of non-standard inflection.

the velar nasal is in retreat. As can be seen in Fig. 8, only one of my informants (speaker 02) has short pronunciation in the expected medial environment.

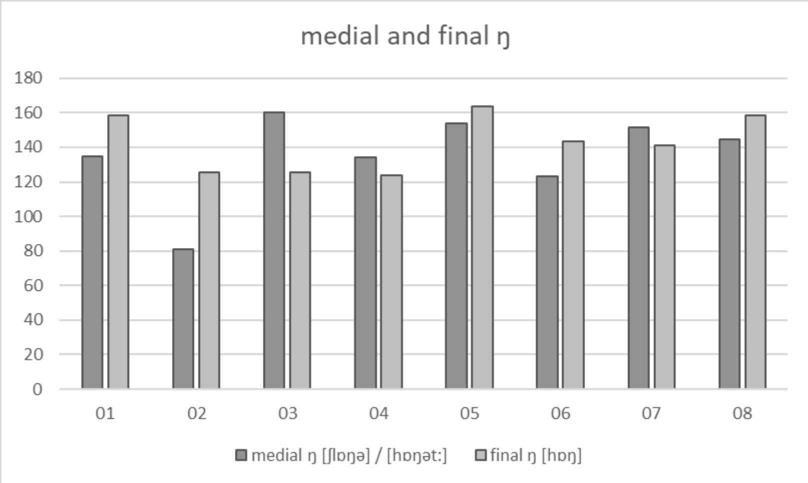

Fig. 8: Duration of medial and final /ŋ/ (in ms) (n = 16/8)

These findings give rise to the assumption that the velar nasals are geminates. This, too, seems to be a recent development. However, the results are based on sparse data. I leave it to future research.

2.3.2.3. A note on /r/

The ZG rhotic is typically an apical trill. Schobinger (2007: 17) mentions [ʀ] as a speaker-specific variant.[58] From a typological viewpoint, the absence of geminate r is little surprising. Drawing on Podesva (2002) who notes that geminate sonorants are generally dispreferred, Kawahara (2005: 145) establishes a sonority scale for geminates arguing that “the more sonorous a geminate is, the more marked it is”. Historically, geminate r was “not uncommon” in Old High German (Braune & Reiffenstein 2004: 119) and still existed in MHG (Schmidt 1996: 238). Contrary to other sonorant geminates that often resulted from West Germanic Gemination, r did not (or only rarely) undergo gemination after short vowels (Paul 2007: 127; Braune & Reiffenstein 2004: 99).[59]

[58] Seven out of eight of my informants produced apical [r]. One speaker (01) had uvular [ʁ].

[59] Cf. Hall (2004) for an analysis on why West Germanic Gemination left /r/ largely unaffected.

For the *Kerenzer Mundart,* Winteler (1876: 76f.) also stresses the uniqueness of /r/ in that it is the only sonorant that has no long variant.[60] Stucki (1921: 60) mentions two contexts where the constraint against geminate r is visible.

First, fake geminates created by a sequence of two identical sounds at the morpheme boundary are prohibited, too. The examples in (21) show that this does not hold for sonorants in general. Fake geminates emerge via morpheme concatenation (a), in (b) it involves place assimilation of the coronal nasal (cf. 2.4.1). In contrast, sequences of /r/ at morpheme boundaries do not result in a geminate (c):

(21)	a.	um+motlə	[umːotlə]	‘remodel, alter (inf.)’
	b.	un+møkli	[umːøkli]	‘impossible’
	c.	fər+rɒːtːə	[fərɒːtːə]	‘reveal (inf.)’
		fər+ruk͡xt	[fəruk͡xt]	‘mad’

Second, etymologically geminate rhotics are systematically short in ZG. The MHG words in the left column of (22) have geminate r, while the corresponding sound is short in ZG. Note that contrary to (18), -*ər* does not trigger gemination in the first example.

(22)		MHG	ZG	
	a.	*pharrære, pharrer*	[p͡fɒːrər]	‘parson’
		karre(n)	[xɒːrə]	‘car’
		plerren	[pːlɛːrə]	‘blare (inf.)
	b.	*scharren*	[ʃɒrə]	‘scratch (inf.)’
		snurren	[ʃnurə]	‘purr (inf.)’

In the MHG examples in (22), the vowel is short throughout. In ZG, however, /r/ is preceded by either a long vowel (a) or a short vowel (b). According to Weber (1948: 70) vowels followed by /r/ are always lengthened.[61] As can be seen from the examples in (23), lengthening also takes place when /r/ is the first member of a consonant cluster.

(23)	MHG	ZG	
	korp	[xoːrp]	‘basket’
	sturz	[ʃtuːrt͡s]	‘fall’
	warm	[ʋɒːrm]	‘warm (adj.)’
	würgen	[ʋyːrkə]	‘choke (inf.)’
	gërste	[kɛːrʃtə]	‘barley’

[60] Arguably, /r/ may be optionally long in a handful of proper nouns like *Andorra, Gomorrha*.

[61] Note, however, that many speakers of ZG – including myself – have a short vowel in the examples in (22)a). In fact, all eight speakers have short vowel for [xɒrə] (recording No. 326).

Both, Weber (1948: 70f.) and Stucki (1921: 31ff.) report exceptions. Examples with short vowels are given in (24) below.

(24) [nɒrpə] 'scar'
[ʃturm] 'storm'
[morkə] 'morning'
[hirʃ] 'stag'

Weber (1948: 70f.) attempts to explain lengthening before r systematically by defining three classes that escape the process. First, exceptions are mostly loans. Second, /rp/ sequences that derived from /rʊ/ (i.e. MHG *narwe* 'scar') did not undergo lengthening either. Third, the varying vowel length before /rn/ sequences is attributed to extralinguistic circumstances, claiming that long vowels occurring more frequently in rural areas.

I fail to recognise a system that accounts for the distribution between long and short vowels. The words Weber considers loans (e.g. [hɛrtː] 'hard', [fɛrtːik] 'finished') strike me as rather unmarked. Furthermore, it is questionable how a language learner is to distinguish between derived and underived /rp/ clusters. Vowel length before r therefore is not entirely predictable, and variation is likely to occur. The chart below gives a short survey of how the vowel lengths vary among the speakers in the corpus. The pronunciations Weber considered correct are in boldface. If we take Weber as a reference point, it is noteworthy that none of the speakers is flawless.

(25)	01	02	03	04	05	06	07	08
[hɛːrt] 'cooker'	short	short	short	short	**long**	short	**long**	short
[ʃtɛːrn] 'star'	**long**	short	short	short	**long**	short	**long**	short
[hɛrtː] 'hard'	**short**	**short**	**short**	**short**	**short**	**short**	long	**short**
[hirʃː] 'stag'	**short**	**short**	**short**	**short**	**short**	**short**	long	**short**
[ʃturm] 'storm'	**short**	**short**	**short**	**short**	long	long	long	**short**

Compared to the nasals and the lateral discussed in 2.3.2.1, r has no allophonic variant. Winteler (1876: 77) proposes that the preceding vowel is lengthened as a consequence of the inability of /r/ to fortify. Thus, vowel lengthening occurs in the very context where the other sonorants are lengthened themselves by Winteler's Law (2.4.4).[62]

This line of thought certainly is much appealing; however, the fact that lengthening is no longer regular casts some doubt on its validity. Let us finally look at the data on /r/ from the corpus. Fig. 9 shows the durations of medial and final /r/. In the case of the latter, the target words /hɛːr/ 'gentleman' and /kʃiːr/ 'dishes (sg.)' were looked at separately. This became necessary as for /hɛːr/, all speakers had a short vowel.[63]

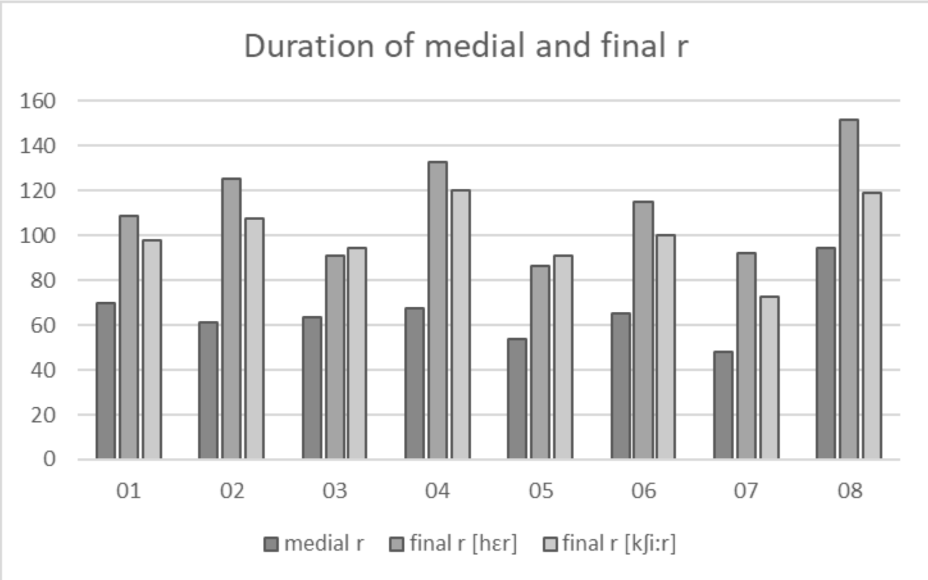

Fig. 9: Duration (in ms) of medial and final r (n = 56)

Due to the scarce data, no general conclusions can be drawn. The results above, however, suggest that final /r/ has a longer duration, especially when it is preceded by a short vowel. Since this is the environment that triggers lengthening for the other sonorants, the measurements could indicate that /r/ is detaching from its special status and taking over the patterns of the other sonorants.[64]

2.4. Phonological processes

Due to several processes, ZG surface forms sometimes differ considerably from their underlying form. Moulton (1986) names three (external) sandhi phenomena: neutralisation, assimilation, and epenthesis. They apply over morpheme and word

[62] See also Keller (1961:43f.) and Page (2001: 139) for a similar explanation.

[63] The words for medial /r/ were: [xɒrə] 'car', [irət] 'err (1.pl.)', [ʊirə] 'confused (nom.sg.m.strong infl.)', [fɛːrə] 'ferry' and [fɒːrət] 'drive (1.pl.)'. One speaker (02) pronounced /kʃiːr/ with a short vowel.

[64] This does not hold for the adjectives, however. With one exception, my informants used short medial /r/ in the inflected form of the adjective *wirr* 'confused' in *en wirre Chopf* 'a spinning head' (n = 8, mean duration: 64 ms).

boundaries alike. Before discussing the neutralisation processes, I will briefly outline assimilation and epenthesis in ZG in the first two sections. They are included here for two reasons. First, the decision to limit the phonetic investigation in Chapter 6 to labial sounds is closely related to ZG assimilation phenomena. Second, assimilation and epenthesis provide additional evidence that ZG syllabification indeed operates across word boundaries. Sections 2.4.3 and 2.4.4 are devoted to the neutralisation processes formulated in Heusler's Law and Winteler's Law, respectively, which form the core of the present thesis. A final and particularly relevant process is Monosyllabic Lengthening, which will be discussed in 2.4.5. Monosyllabic Lengthening is directly connected with minimality conditions, which I have already mentioned in passing. As will soon become apparent, Monosyllabic Lengthening is of paramount importance for the analysis of *fortes* as geminates.

2.4.1. Assimilation

ZG has several assimilation processes that are operative both word-internally and across word boundaries. Roughly, they can be divided into two main categories: (1) formation of the past participle, and (2) coronal assimilation. I will briefly discuss them in turn.

ZG past participles are formed by adding a prefix *gg-* [kː] to the stem.[65] (26) shows infinitive – past participle pairs. The prefix undergoes total assimilation when it is followed by a stop (a), while otherwise it retains its place of articulation (b).

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[65] I assume that /kː/ is the underlying form. It corresponds to the *ge-* prefix in StG and emerged via schwa syncope. However, other underlying representations have been put forward by Kraehenmann (1996) for Thurgovian and Ham (1998) for Bernese. Ham (1998: 114f.) proposes that the underlying form is /g̊-/ and argues that the geminate is the product of "total regressive assimilation". Such an analysis is not applicable for ZG. In ZG, there is no evidence for a gemination process. In Bernese, the past participle of *impfe* 'vaccinate' is *gimpfet*, where the prefix surfaces as /g̊/. By contrast, the participle invariably has a geminate in ZG, even if the verb stem is vowel-initial, cf. (26)b). Kraehenmann (1996: 81f.; 109ff.) posits underlying /ge-/. In past participle formation, the prefix /ge-/ "loses its vowel and strengthens its remaining consonant" if it precedes a sound other than a stop (where total assimilation takes place). Kraehenmann's main argument relies heavily on a word formation process where the vowel is retained despite the following stop, e.g. [gedrɛŋ] 'crowd', [gepːlawdəʀ] 'chat'. This kind of word formation is also found in ZG. However, there is no reason why participle formation works accordingly. Rather, ZG has forms that point in the opposite direction: Words such as [pːiə̯tː] 'area' > MHG *gebiet(e)*, or [pːuːr] 'farmer' > MHG *gebūr(e)* again show total assimilation, suggesting that schwa syncope had a wider reach than probably expected. Cf. also 4.3.3.

(26)	a.	[pɒxːə] ‘bake’	kː + pɒxːətː ‘baked’	[pːɒxːətː]
		[tiə̯nə] ‘serve’	kː + tːiə̯nətː ‘served’	[tːiə̯nətː]
		[kɒː] ‘go’	[kːɒŋə] ‘gone’	
	b.	[fintə] ‘find’	[kːfuntə] ‘found’	
		[mɒːlə] ‘paint’	[kːmɒːltː] ‘painted’	
		[ʋɛːlə] ‘chose’	[kːʋɛːltː] ‘chosen’	
		[hælfːə] ‘help’	[kːhulfːə] ‘helped’	
		[æntərə] ‘change’	[kːæntərətː] ‘changed’	

According to Winteler (1876: 28f., 131f.) adjacent homorganic stops are produced with a single articulatory gesture. Assimilation processes of geminate stops as in (27) result in what he calls “potenzirte Fortis [multiplied *fortis*]”. Unfortunately, Winteler says little about the actual phonetic outcome. The phonetic transcription of the past participles in (27)c) below must thus be viewed as an interpretation of Winteler’s claims.[66]

(27)	a.	[tːriŋk͡xə] ‘drink’	b.	kː + tːruŋk͡xə ‘drunk’	c.	[tːːruŋk͡xə]
		[pːlɒːkə] ‘tease’		kː + pːlɒːkətː ‘teased’		[pːːlɒːkətː]

Place assimilation of coronal consonants is the most widespread sandhi process of ZG. Coronals are notorious for place assimilation (cf. Kiparsky 1985; Avery & Rice 1989). In ZG, this holds for stops and nasals as well as, in a limited sense, for fricatives.[67]

Coronal stops and nasals generally assimilate in place to a following nasal or obstruent. The examples in (28) from Weber (1948: 39ff.) show that assimilation applies across morpheme (a) and word boundaries (b). It affects coronal clusters, too (c).[68]

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66 Winteler (1876: 29) asserts that a “difference is definitely felt [Unterschied wird ganz entschieden empfunden]”. In fact, he gives examples where assimilation rules supposedly multiply the strength of *lenis* stops up to seven times. There are to my knowledge no phonetic studies that corroborate these claims. Dieth & Brunner (1943: 746) report a difference that is very small. Ham (1998) measured the closure durations of the initial stops of past participles and word-initial non-derived geminate stops in Bernese. He (1998: 125) concluded that initial stops “appear to be more or less equivalent in length.” Zihlmann (2017) measured initial stops that underwent assimilation with the preceding definite article (see below). He found that despite a closure duration that is shorter than that of true geminates, the resulting sounds are perceived as geminates.

67 See Féry & Meier (1993) for an in-depth phonological account of ZG coronals. They argue that coronal stops and nasals are underspecified for place, thus, the spreading of the place feature of the following consonant is a structure-filling process. For a detailed overview on the special behaviour of coronals in general see Grijzenhout (1998) and Hall (2011), and the references therein.

68 The duration of the resulting sounds is not clear due to obstruent cluster neutralisation (i.e. Heusler’s Law, cf. 2.4.3). Stops preceding a nasal are usually unreleased, e.g. proːp˺mæsːər, ʋimp˺myli. Fleischer & Schmid (2006: 249) also report glottalisation. In my (introspective) view, no singleton/geminate contrast is discernible.

(28)	a.	/ɒltː/ + /pːɒxːə/	→ [ɒlpːaxːə]	‘frumpy (lit. old baked)’
		/kolt/ + /fɒsɒːn/	→ [kolpfɒsɒːn]	‘golden pheasant’
		/proːtː/ + /mæsːər/	→ [proːpmæsːər]	‘bread knife’
	b.	/nyːtː pøːsəs/	→ [nyːpːøːsəs]	‘nothing evil’
		/ʋæn xunʃ/	→ [ʋæŋxunʃ]	‘when do you come?’
		/mitː fliːsː/	→ [mipfliːsː]	‘on purpose (lit. with ambition)’
		/ən mɒː/	→ [əmːɒː]	‘a man (nom./acc.)’
	c.	/hɒnt/ + /præitːi/	→ [hɒmpːræitːi]	‘a hand’s breadth’
		/ʋint/ + /myli/	→ [ʋimpmyli]	‘windmill’
		/kroːsː unt xliː/	→ [kroːsːuŋkxliː]	‘big and small’

This process is also responsible for the assimilation of the definite article to the following noun. In ZG, the definite article is /tː/ in the nominative and accusative plural and for the feminine singular, e.g. /tː oːrə/ ‘the ears (m.pl.)’, /tː yːlə/ ‘the owl (f.sg.)’.[69] Assimilation occurs when the article precedes an obstruent or a nasal. In the case of stops, this leads to total assimilation (c). Elsewhere, the definite article appears as /tː/ (d), cf. Weber (1948: 103).[70]

(29)	a.	/tː xuklə/	→ [kxuklə]	‘the globe’
		/tː fiʃː/	→ [pfiʃː]	‘the fishes’
	b.	/tː milx/	→ [p˺milx]	‘the milk’
	c.	/tː kɒplə/	→ [kːɒplə]	‘the fork’,
		/tː pɛːrə/	→ [pːɛːrə]	‘the bears’
	d.	/tː yːlə/	→ [tːyːlə]	‘the owl’
		/tː rolə/	→ [tːrolə]	‘the role’
		/tː hæfə/	→ [tːhæfə]	‘the yeast’
		/tː ʋɒfːə/	→ [tːʋɒfːə]	‘the weapon’
		/tː jɒkt/	→ [tːjɒkt]	‘the hunt’
		/tː lyːs/	→ [tːlyːs]	‘the lice’[71]

Finally, the alveolar fricative assimilates to a postalveolar fricative. Examples are given in (30):

(30)	/uːs/ + /ʃlɒːk/	→ [uːʃːlɒːk]	‘rash’
	/əs ʃifː/	→ [əʃːifː]	‘a ship’
	/s ʃneitː/	→ [ʃːneitː]	‘it snows’
	/t͡s ʃɒfːə/	→ [t͡ʃɒfːə]	‘to work (inf.)’

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69 The definite article in ZG has two forms: /tː/ immediately precedes nouns and /ti/ occurs before adjectives, cf. Weber (1948: 107).

70 According to Heusler’s Law, duration of the assimilated stop in (29)a) is shorter than an intervocalic geminate.

71 It is unclear to me whether assimilation occurs when the coronal is followed by the lateral /l/. To my knowledge, the issue has not been looked at systematically. However, my impression is that the stop has a lateral release. This is in accord with Winteler (1876: 133) who also reports “lateral aperture” of the coronal stop.

Weber (1948) mentions regressive and progressive assimilation of the alveolar sibilant. However, I concur with Fleischer & Schmid (2006: 249) that progressive assimilation is optional and restricted to the second person singular ending /ʃ/ when followed by the 3rd singular feminine clitic /si/ 'she/her (nom./acc.)':

(31) /hæʃ si kseː/ → [hæʃːi kseː] 'have you seen her?' (Schobinger 2008: 13)
/iʃ si xoː/ → [iʃːi xoː] 'has she come?' (Weber 1948: 42)

Crucially, assimilation does not occur when the coronal precedes /r/ or an approximant. The examples in (29)d) illustrate this. This is clear evidence that the obstruents pattern as a natural class. It further proves that the labiodental phoneme /ʋ/ is indeed an approximant.[72]

2.4.2. Linking-*n*

ZG has no *Wortgrenzsignale* (Trubetzkoy 1989: 170, 241ff.). Provided the phonotactic conditions are met, word-final consonants are syllabified in the onset of the following word (see also Section 4.4). To avoid hiatus, ZG (and other Swiss dialects) has epenthetic consonants, most prominently the so-called "Binde-*n*" (linking-*n*) (Heusler 1888: 111f.; Weber 1948: 46ff.; Moulton 1986: 390; Fleischer & Schmid 2006: 249).[73]

Historically, the development of linking-*n* is comparable to that of intrusive-*r* in non-rhotic English varieties (cf. Nespor & Vogel 1982, 1986; Vogel 1986; Broadbent 1991; Ortmann 1998): final /r/ was deleted unless it was followed by a vowel. In this case, it served as a liaison element. The sheer predictability of the presence or absence of /r/ eventually led to a reanalysis of /r/ as an epenthetic element. As a result, linking-*r*

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72 The ZG phoneme system differs from StG in this regard. StG has an opposition /v/ vs /f/, e.g. *Wetter* 'weather' vs *Vetter* 'cousin'. ZG, on the other hand, has three labiodental phonemes: /ʋ/, /f/, and /fː/. However, the contrastive potential is not fully exploited, since the approximant occurs mainly at the beginning of the word, where geminates are not allowed. See also Nocchi & Schmid (2006).

73 Grammars mention /r/ as a second epenthetic consonant. Linking-*r* is restricted to the masculine singular nominative and accusative. Weber (1948: 48) gives the examples [tə-r øpfəl] 'the apple (nom./acc.sg.m)' and [tə-r ɒltː mɒː] 'the old man". While the feminine article in the dative singular is [tər] in Weber's description, he (1948: 102f., fn. 2) concedes that we also encounter /tə/ instead of /tər/. He considers the *r*-less variant to be particularly common for "rural vernaculars", and in frequent contexts. When followed by a vowel, however, /r/ still occurs, cf. [uf tər ɒlpː] 'on alpine pastures (dat.sg.f.)'. Following Moulton's (1986: 391) analysis, Fleischer & Schmid (2006: 249) essentially consider /r/ an epenthetic consonant that "may be seen as a remnant of an older form containing final /r/". My impression is that *r*-insertion is in decline. In contrast, linking-*n* occurs regularly and is not subject to morphological restrictions. Interestingly, the dative singular feminine article never takes a variant containing *n*-epenthesis:
[uf tə inslə] 'on the island (dat.sg.f.)' [uf tə-n inslə] 'on the islands (dat.pl.f.)'
I suggest that [tər] and [tə] are phonologically conditioned allomorphs thus blocking the regular *n*-epenthesis. In the above example, *n*-epenthesis probably is blocked by an underlying empty segment in order to maintain the distinction between the singular and the plural article. Empty segments are also known from other languages (see e.g. Bertinetto & Loporcaro 1988 for an overview).

occurs even if the word has no final /r/. In English, *r*-epenthesis is regular between sequences of non-high vowels to avoid hiatus. ZG linking-*n* is inserted only after schwa.[74] In (32)a), schwa is followed by a consonant, hence the absence of epenthesis. However, if schwa precedes a vowel-initial word (b), a linking element must be inserted.

(32) a. [ə xrɛːjə] 'a crow'
[pu̯əpə kekə mæi̯tːli] 'boys against girls (name of children's game)'
b. [ə-n ɒmslə] 'a blackbird'
[pu̯əpə-n unt mæi̯tːli] 'boys and girls'[75]

The insertion is purely phonological. (33) shows that linking-*n* also occurs in contexts where the occurrence of final *n* cannot be explained by an underlying form. The accusative singular of /jɒkːə/ in (a) never contained *n,* nor did the nominative singular of /riːfːə/ in (b).

(33) a. [sini jɒkːə-n ɒːlekːə] '(to) put on his jacket (acc.)'
b. [ən riːfːə-n øp͡fəl] 'a ripe apple (nom.)'

2.4.3. Heusler's Law

In his study on the consonant system in the city of Basle vernacular, Heusler notes:

> [S]timmlose Lenis und Fortis bewahren ihre gegensätzliche Natur nur in sonorer Umgebung. Treffen zwei oder mehr stimmlose Laute zusammen, so erhalten ihre Articulationen eine gewisse mittlere Intensität, kräftiger als die der Lenis, etwas schwächer als die der Fortis. Wir können für diese Laute die Bezeichnung 'neutrale' brauchen.[76]
>
> Heusler (1888: 24)

Heusler's observation, which became known as Heusler's Law was first mentioned by Winteler. For the *Kerenzer Mundart,* he states that

[74] See Ortmann (1998) and Kabak & Schiering (2006) for consonant epenthesis in German dialects. It has apparently gone unnoticed that epenthesis does not apply when schwa is the second member of a diphthong, e.g. [xyə̯-*n unt ʃœːfː] 'cows and sheep'; Baer & Baur (1937: 7) coincidentally provide [oːni myə̯ unt noːtː] 'without any trouble or need'. As far as I can tell, the absence of *n*-epenthesis in this context is regular, however, I am not aware of any previous description or analysis dealing with this phenomenon.

[75] Strictly speaking, the coronal nasal + stop sequence in /unt/ 'and' undergoes place assimilation and surfaces as a labial sonorant plus an unreleased labial stop [ump̚], cf. fn. 68.

[76] Transl. KW: "Voiceless *lenis* and *fortis* preserve their contrasting nature only in sonorant environment. If two or more voiceless sounds cluster, their articulation is of medium intensity, stronger than the *lenis* articulation and somewhat weaker than that of the *fortis*. We may use the term 'neutral' for these sounds."

> [d]asselbe Gesetz scheint … für eine harte Lenis zu gelten, wenn der ihr folgende Konsonant auch hart ist.[77]
>
> Winteler (1876: 143)

Heusler (1888: 24) respectfully refers to Winteler as the discoverer of obstruent neutralisation. However, as Goblirsch (1994: 55) points out, Winteler wrongly assumed that the law was subject to the same principles as what later became known as Winteler's Law (cf. 2.4.4). That is, Winteler thought that obstruent cluster neutralisation is restricted to tautosyllabic obstruents. According to Goblirsch, Heusler "amended Winteler's law, noting that the following tautosyllabic consonant was not essential to the formula."[78]

Heusler's Law is widely recognised in Swiss dialectology. It states that in obstruent clusters, the *fortis/lenis* contrast is suspended. Heusler's 'neutral' obstruents are commonly termed "half-fortis" (Moulton 1986: 386) or "semi-fortis" (Keller 1961: 45f.). Moulton describes neutralisation as a sandhi process that also takes place across morpheme (34)a) or word boundaries (b). This may lead to ambiguity (c):[79]

(34)	a.	/xlɒk-ʃ/	→ [xlɒk'ʃ']	'moan (2.sg.)' (Weber 1948: 38)
		/ʃriːbə/	→ [ɛr ʃriːp't']	'he writes' (Keller 1961: 46)
	b.	/tə sæp tːɒːk/	→ [tə sæp't'ɒːk]	'this day' (Fleischer & Schmid 2006: 248)
	c.	/əs pɛːrli/	→ [əs'p'ɛːrli]	'a little bear (dim.)' (Würth 2002: 15)
		/əs pːɛːrli/	→ [əs'p'ɛːrli]	'a little pair (dim.)'

Heusler formulated this observation for the vernacular of the City of Basle, but it is also documented for ZG. Ample examples can be found in Stucki (1921: 65), Weber (1948: 38), Keller (1961: 45f.), Moulton (1986: 386f.), Fleischer & Schmid (2006: 248) and Schobinger (2008: 164). Crucially, Heusler's Law occurs irrespective of the nature of the contact.

> In all four patterns, the opposition between fortis and lenis obstruents is neutralized.
>
> Fleischer & Schmid (2006: 248)

[77] Transl. KW: "The same law [Winteler refers to Winteler's Law] also appears to apply to a hard *lenis* [i.e. *lenis* obstruents], if the following consonant is hard, too."

[78] Contrary to Goblirsch (1994: 70) who limits Heusler's Law to intervocalic environments stating that "in contact with other consonants the opposition is neutralized", the opposition is also retained with sonorant consonants: [hɒltə] 'slope' – [hɒltːə] 'stop (inf.)' (cf. Heusler 1888: 28).

[79] Here, I transcribe the "half-fortis" with the symbol [ˑ] to emphasise the intermediate length of the consonant. To facilitate reading, I normally dispense with the marking of neutralised consonants. Note, however, that "half-fortes" are completely predictable as adjacent obstruents are always subject to Heusler's Law.

The examples in (35) illustrate the four contact options. The obstruents at issue always appear as half-fortis.

(35)	a.	*lenis + fortis:*	/loːp/ + /tː/	→ [loːp˙t˙]	'praises (3.sg.)'
	b.	*lenis + lenis:*	/loːp/ + /ʃ/	→ [loːp˙ʃ˙]	'praise (2.sg.)'
	c.	*fortis + lenis:*	/ʃnɒpː/ + /sofortː/	→ [ʃnɒp˙s˙ofortː]	'snatch at once!'
	d.	*fortis + fortis:*	/k͡xlɒpː/ + /tːiʃ/	→ [k͡xlɒp˙t˙iʃ]	'folding table'

Obstruent clusters also occur in simplex words. Examples are given in (36) for the native vocabulary (a) and for loan words (b). Apart from ʃt and ʃp sequences, native words do not have initial obstruent clusters.[80] Somewhat more "exotic" structures are found in borrowings. Note that the second obstruent is a coronal.

(36)	a.	[ɒp˙t˙]	'abbot'
		[fux˙s˙]	'fox'
	b.	[p˙s˙ɒlm]	'psalm'
		[rep˙ˈt˙iːl]	'reptile'
		[ˈlɒp˙s˙us]	'lapse'

The reality of obstruent cluster neutralisation is also corroborated by rhymes. The examples in (37) are taken from the ZG rhyming dictionary (Walter 2004). They provide further evidence that consecutive obstruents surface as "half-fortis".

(37)	entry		gloss
	acht	/ɒxt/	'eight'
	lacht	/lɒxː/ + /tː/	'laughs (3.sg.)'
	macht	/mɒx/ + /tː/	'makes (3.sg.)'
	Häx	/hæks/	'witch'
	sägs	/sæk/ + /s/	'say (2.sg.) it (acc.n.)'
	Chraft	/xrɒft/	'power'
	schafft	/ʃɒfː/ + /tː/	'works (3.sg.)'
	Schnöiz	/ʃnoi̯t͡s/	'moustaches (pl.)'
	röits	/roi̯/ + /tː/ + /s/	'regrets (3.sg.) it (acc.n.)'

Winteler notes that in intersonorant context, the contrast is maintained:

> Eine harte Fortis ist ausserdem mit voller Sicherheit von der Lenis nur unterscheidbar zwischen tönenden Lauten; insbesondere ist harte Lenis und

[80] If we analysed homorganic stop + fricative combinations as a sequence of two independent consonants and not as affricates, they would constitute another set of tautomorphemic obstruent clusters that can occur initially. I am not aware of any phonetic investigation for ZG. In my perception, the simplex noun [t͡siːl] 'goal' and [tsiːl] 'the Sihl (river name)', a combination of the definite feminine article /tː/ and the proper noun /siːl/, are homophones.

> Fortis ununterscheidbar zwischen langem Vokal, Diphthong oder Liquida und hartem Laute, oder nach hartem Laute.[81]
>
> Winteler (1888: 144)

In a similar vein, Moulton (1986: 386) stresses that the "opposition lenis≠fortis is … maintained in just one environment: between voiced [i.e. sonorant] phonemes. In all other environments, namely in sequences of obstruents …, the lenis≠fortis opposition is suspended, and the neutralized obstruents that appear are what Swiss phoneticians call 'half fortis'."

Although the phonetic nature of the half-fortes is somewhat opaque, most dialectologists seem to agree that it is closer to a *fortis* than a *lenis*.[82] Stucki even suggests that the neutralised form equals the *fortis* (which he calls "strong grade"):

> Die schwache und die starke Stufe bewahren ihre gegensätzliche Natur nur in stimmhafter Umgebung; treffen zwei oder mehrere stimmlose Laute zusammen, so erscheinen alle als starke Stufe […][83]
>
> Stucki (1921: 65)

Taking the term "half-fortis" seriously, we have to conclude that the resulting sound is somewhere between the *fortis/lenis* poles. On the assumption that the *fortis/lenis* opposition is, in fact, a contrast between geminate and singleton consonants (more on this in Section 4.3), we would expect the "neutralised" sounds to be phonetically longer than a singleton consonant and shorter than a geminate. Goblirsch (1994: 18) explicitly mentions the close connection between *fortis/lenis* and duration: when "the opposition between fortis and lenis is neutralized …, the difference in length is also neutralized."

2.4.4. Winteler's Law

Winteler (1876: 142f.) formulated his *Silbenakzentgesetz* for his native Kerenzen dialect. Heusler (1888) provides an abbreviated version:

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81 Transl. KW: "A hard *fortis* [i.e. *fortis* obstruent] can only be clearly distinguished from a *lenis* between sonorant sounds; in particular, hard *lenis* and *fortis* are indistinguishable between long vowel, diphthong or liquid and hard sounds, or after a hard sound."

82 See, however Kraehenmann (2003) for an alternative analysis. I will come back to her approach and its implications in 5.2.3.

83 Transl. KW: "The weak and the strong grade preserve their opposing nature only in a voiced environment; if two or more voiceless sounds come together, they all appear as strong grade." In a similar vein, Gallmann & Seiler (2000) exclude *lenis* consonants from obstruent clusters.

> Bei den Sonorlauten erscheint jede etymologisch zu erwartende Lenis, welcher ein kurzer starktoniger Vocal vorangeht, als Fortis, sobald ihr noch ein Consonant (meist ein stimmloser) sich anschliesst.[84]
>
> Heusler (1888: 12)

Winteler's Law affects the lateral /l/ (a) as well as all nasal consonants (b). Examples from Winteler are given in (38). For readability, the respective sounds are put in boldface.[85]

(38) a. [ʋɒ**lː**t], [ɒ**lː**tː], [hy**lː**fː], [me**lː**xə], 'forest, old, help, milk (inf.)'
  b. [lɒ**nː**t], [ku**mː**pːə], [tːri**ŋː**kə] 'land, jump (inf.), drink (inf.)'

Winteler's Law results in paradigmatic alternations, as illustrated in (39). In the first column, the stem-final sonorant is followed by the vowel-initial plural ending, which is *-ət* in all plural forms. In the second and third column, the inflectional ending is an obstruent. In these cases, Winteler's Law predicts lengthening.

(39)

pl.	2.sg	3.sg	
[fylət]	[fylːʃ]	[fylːtː]	'fill'
[k͡xænət]	[k͡xænːʃ]	[k͡xænːtː]	'know'
[ʃæmət]	[ʃæmːʃ]	[ʃæmːtː]	'be ashamed'
[ʃʋymət]	[ʃʋymːʃ]	[ʃʋymːtː]	'swim'

Winteler's Law does not predict lengthening when the preceding vowel is long (40).

(40)

pl.	2.sg	3.sg	
[hyːlət]	[hyːlʃ]	[hyːltː]	'cry'
[ɒːnət]	[ɒːnʃ]	[ɒːntː]	'guess'

According to Winteler (1876: 142), lengthening also occurs across morpheme and word boundaries. Some of his examples are given in (41). Winteler's Law always

84 Transl. KW: "An etymologically *lenis* sonorant consonant in an accented syllable is strengthened to *fortis* when preceded by a short vowel and followed by another (normally voiceless) consonant." In the original version, Winteler establishes a tripartite consonant system: On the one hand, he distinguishes "harte [hard]" sounds (i.e. obstruents) from "tönenden [sonorant]" sounds (i.e. sonorant consonants). /r/, on the other hand, belongs to a third category, which he calls "weich [soft]". Goblirsch (1994: 55) defines Winteler's Law as the strengthening of "a sonorant […] to fortis after a short vowel if it stands in an accented syllable and is followed by a tautosyllabic consonant." Note however, that Winteler's concept of syllabicity differs from contemporary ones. When Winteler speaks of consonants that belong to the same syllable – "welcher der nämlichen Sprachsilbe angehört" – he follows the tradition of Sievers's *Drucksilbe* (cf. 1901: 198ff.), as the disyllabic examples in (38) clearly indicate. The question of whether Winteler's Law only applies a) after short consonants and b) when preceded by obstruents is addressed in 6.3.4.

85 Winteler's (1876: 142) transcription is not straightforward to interpret. He states that *lenis* become *fortis* under the conditions formulated in Winteler's Law, and represents the respective sonorant by double letters (e.g. *walld*). However, since the notion of 'half-fortis' was introduced only later, it is unclear whether Winteler assumed that fortified sonorants and *fortis* sonorants are phonetically the same.

applies when the sonorant is followed by a consonant-initial word, be it an enclitic (a), the second member of a compound (b), or in any other phrasal context (c).

(41) a. [ʃæmː + ti] ‘be ashamed (imp.sg.)’
[ʃpilː + nyːt] ‘don’t play (lit. play (imp.sg.) not)’
b. [melː + pɛːri] ‘mountain ash (lit. flour berry)’
c. [ʃpɒnː + tox + ɒː] ‘hitch up (e.g. the horses)’

Winteler (1876: 69f.) also describes lengthening phrase-finally. If it is followed by a vowel-initial enclitic, however, the sonorant remains short, cf. (42):

(42) [nimː] ‘take (imp.sg.)
[nim-ən] ‘take him (imp.sg.)’

Entries from Walter’s (2004) rhyming dictionary again corroborate Winteler’s claims. (43) shows how the sonorant alternates under Winteler’s Law.

(43)	entry		gloss	entry		
	knale	/k͡xnɒlə/	‘bang (inf.)’	*Chrale*	/xrɒlə/	‘claw’
	Knall	/k͡xnɒl/	‘bang’	*Metall*	/meˈtːɒl/	‘metal’
	knallt	/k͡xnɒl/ + /tː/	‘bang (3.sg.)’	*alt*	/ɒltː/	‘old’
	spile	/ʃpilə/	‘play (inf.)’	*Chile*	/xilə/	‘church’
	still	/ʃtil/	‘silent’	*Grill*	/kril/	‘grill’
	spilt	/ʃpil/ + /tː/	‘play (3.sg.)’	*stillt*	/ʃtil/ + /tː/	‘breast-feed (3.sg.) (lit. silence)’

For ZG, Schobinger (2008: 164) also notes that “in verbs and adjectives, the consonants change depending on the environment”.[86] He further notes that the alternation only applies after short vowels. (44) gives some of his examples.[87]

(44) a. ʃʋymə ‘swim (1.sg.)’ ʃʋymːʃ ‘swim (2.sg.)’
b. ən tːumə xæi̯p ‘a stupid git’ ər iʃ tːumː ‘he is stupid’
c. finːtə ‘find (1.sg.)’ finːtʃ ‘find (2.sg.)
xinːt ‘child’

Heusler (1888: 12f.) makes an essential modification by arguing that the conditioning factor is not the following consonant, but the position within the syllable. Sonorants are lengthened in coda position whereas they remain short when they precede a vowel.

Page (2001) interprets Winteler’s Law as a consequence of a more general constraint that prohibits the immediate vicinity of short stressed vowels and short (i.e. *lenis*)

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86 Orig.: “Bim wèrb und bim adiektiiv wächslet d konsonante jee nach der umgäbig.”

87 I do not know why he explicitly restricts alternations to adjectives and verbs, but I suspect it is because for nouns, paradigmatic alternation hardly ever occurs, cf. fn. 50. As can be seen in (c), Schobinger assumes that long sonorants occur in the coda position.

consonants within the same syllable. Thus, whenever a short vowel precedes a short tautosyllabic consonant, lengthening takes place. Lengthening can either affect the sonorant consonants discussed above or the vowel. In the latter case, this leads to vowel length alternations such as [hɒːs] 'rabbit' ~ [hɒsə] 'rabbits (pl.)', a phenomenon known as Monosyllabic Lengthening, which I will discuss in the next subsection.[88] Elaborating on Keller's (1961: 47) observation that "consonantal readjustment is only possible where is [sic] does not involve a change from one phoneme to another", Page (2001: 239) concludes that lengthening of singleton obstruents is blocked because the "consonant is contrastively short".

In sum, Winteler's Law states that all sonorant consonants except /r/ lengthen when preceded by a tautosyllabic short vowel.

Winteler and his successors' method is based on attentive perception and introspection. To my knowledge, there are hardly any empirical studies on Winteler's Law. The only investigations known to me (Willi 1990; Seiler & Würth 2008, cf. 6.1), could only partly confirm Winteler's claims. In particular, the question of whether Winteler's Law applies exclusively after short vowels awaits clarification. The phonetic study in Chapter 6 is intended to remedy this deficiency.

The previous two sections about Heusler's Law and Winteler's Law have shown that certain positions are affected by neutralisation. Heusler's Law states that adjacent obstruents are subject to neutralisation. Winteler's Law states that sonorants in coda position are lengthened after short vowels. Depending on the position in the syllable, long and short sonorants alternate without being contrastive. This is also reflected in the observation already mentioned in 2.3.2.1: long vowels precede short sonorants, and short vowels precede long sonorants. Closely related to this mutually exclusive distribution of vowel and consonant length is a further principle that has already been mentioned in part: monosyllabic words of the structure short vowel + short consonant are prohibited. This also holds for words that end in an obstruent. The following section is about such words.

[88] Page (2001) calls it CSL (Closed Syllable Lengthening) as opposed to OSL (Open Syllable Lengthening). He (2001: 242) provides examples from the dialect of Visperterminen in the Canton Valais, which has no OSL; however, vowel lengthening occurs before r also word-medially: xoːrp – xeːrpli 'basket, basket (dim.)'. In the case of ZG, this would be a somewhat misleading term as it does not adequately capture the fact that CSL only affects monosyllabic words.

2.4.5. Monosyllabic Lengthening

The lengthening of short vowels in monosyllabic words – Monosyllabic Lengthening, henceforth: MSL – is widely acknowledged in German and Germanic linguistics (e.g. Winteler 1876, Heusler 1888, Stucki 1921, and Weber 1948 for Alemannic; Naiditsch & Kusmenko (1992), Kusmenko (1995), Naiditsch (1997), Page (2001), Seiler (2009), and Goblirsch (2018) on MSL from a broader comparative perspective).

In Swiss dialectology, MSL is known by the term “Leichtschlussdehnung” [lit. ‘lengthening of light endings’, cf. Bohnenberger 1953: 155]. It essentially states that monosyllabic words ending in a singleton consonant have a long vowel.[89]

(45) shows that ZG has paradigmatic alternations where long vowels occur in monosyllabic forms and short vowels in the disyllabic form. As can be gleaned from the disyllabic forms, ZG allows short vowels in open stressed syllables.

(45)		singular	plural	diminutive	
	a.	[hɒːs]	[hɒsə]	[hæsli]	‘rabbit’
		[kliːt]	[klitər]	[klitli]	‘limb’
	b.	[ʃlɒːk]	[ʃlɛːk]	[ʃlekli]	‘stroke’
	c.	[huːs]	[hyːsər]	[hyːsli]	‘house
		[koːf]	[koːfə]	[køːfli]	‘child (coll.)’

Note that these alternations are indeed the result of a lengthening process. They cannot be attributed to morphology as monosyllabic plural forms are lengthened as well (b). Neither can the disyllabic forms be analysed as shortenings, since the long vowel in (c) remains long throughout the paradigm.

Some preliminary observations are in order here. First, the restriction only holds for content words. Monosyllabic function words often occur with short vowels (but see 4.3.1). Second, verb forms are excluded from MSL, in particular, in the imperative singular, and in the third person singular subjunctive (e.g. [kip] ‘give!’ [ix kɛp] ‘I would give’).[90] And third, there are a handful of words that apparently escape the general pattern. I will address these issues in due course.

[89] See, however, Seiler (2009) on cases of MSL where the final consonant is lengthened instead.

[90] As for the subjunctive, speakers sometimes avail themselves of a bisyllabic alternative – [ix kɛpi] –, yet this is not an option for the imperative. Weber (1948: 181) mentions a tendency to render short forms disyllabic. He notes that vowel-initial clitics are normally preceded by monosyllabic forms. These cases may be interpreted as an incorporation of the enclitic into the phonological word, rendering it disyllabic, too.

2.5. Summary

This chapter has presented the phoneme system of ZG. It became clear that in ZG, vowels and consonants both have contrastive length.

In the case of the obstruents, length is not predictable by the length of a preceding vowel. Accordingly, geminates occur after both short and long vowels. In contrast, the distribution of long and short sonorants is largely allophonic: short sonorants occur after long vowels and vice versa. At least, this is how it is described in the grammars of ZG. However, I have pointed out that there are deviations in two areas: first, words that end in -*ər* appear to trigger lengthening, and secondly, adjectives tend to keep consonant length constant across the paradigm. In both cases, we seem to be dealing with recent developments that are probably still ongoing.

Stops have distinctive length in all positions in the word. As for the fricatives, geminates occur only word-medially and word-finally; for palatal and velar fricatives, the distribution is near-allophonic.

The distribution of the velar nasal is defective, as it is permitted only in medial and final contexts. Its behaviour in terms of length is unclear. Grammars report that the velar nasal is short in a medial environment, but my measurements show that it is pronounced as long by many speakers.

The only sonorant that does not have a long variant is /r/. Instead, the preceding vowel is lengthened. Again, these conditions seem to shift. Some measurements indicate that /r/ is longer after a short vowel. Further research is needed here.

ZG has several sandhi processes that can considerably alter the surface shape. Regressive place assimilation and linking processes regularly take place across word and morpheme boundaries. ZG evidently does not signal word boundaries.

Both Heusler's Law and Winteler's Law also operate across word boundaries. The former states that subsequent obstruents are neutralised. The latter states that tautosyllabic sonorants are lengthened when preceded by a short consonant. I will resume the discussion in 5.2.2.

In SwG dialectology, it is customary to distinguish homorganic obstruent series by *fortis/lenis*. This assumption encounters difficulties that will be discussed in the next chapter. In anticipation of what is explained in more detail in Chapter 4, the two series are better analysed as a distinction between singleton and geminate. This analysis seems to be more adequate, as it also accounts for a number of prosodic phenomena, including MSL.

3. The *fortis/lenis* distinction

The *fortis/lenis* contrast has already been touched upon in the previous chapter. It was introduced by the Swiss dialectologist Jost Winteler who stated that the

> Gegensatz zwischen dem schweizerischen – vielleicht überhaupt oberdeutschen – Konsonantismus einerseits, und demjenigen der umgebenden Sprachformen andrerseits, kann also dahin präzisirt werden, dass der erstere die im letztern geläufige qualitative Unterscheidung von harten und weichen Lauten verdrängt hat durch eine neue, graduelle oder quantitative. Zur Bezeichnung der beiden Seiten dieses schweizerischen Gegensatzes homorganer Laute dürften sich die Namen *Fortis und Lenis* am besten eignen.[91]
>
> Winteler (1876: 22; emphasis added)

Dialect descriptions adopted Winteler’s proposal. The standard assumption is that SwG has homorganic fricative and plosive series that are voiceless and unaspirated.[92] For this reason, *fortis/lenis* appears to be particularly well-suited for capturing the two-way contrast. On a more superficial level laid out in 2.1, this had an effect on the transcription: *lenis* obstruents are traditionally transcribed as voiced sounds with a devoicing diacritic (e.g. /b̥/) and *fortis* obstruents are represented as voiceless (e.g. /p/). The inadequacy of the transcription, however, is not a mere matter of academic pedantry. Rather, it reveals a more general problem, which is rooted, firstly, in the ambiguous use of *fortis/lenis,* and secondly, in theoretical assumptions concerning the phonology-phonetics interface.

This chapter deals with the origin, the nature and theoretical implications of *fortis/lenis*. An overview of the historical development of the *fortis/lenis* distinction is provided in 3.1. It turns out that over time the terms have been used for various purposes and with changing meanings and functions. This is indicative of the lack of a clear phonetic

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91 Transl. KW: “We can thus specify the difference between the consonants in Swiss German – maybe Upper German in general – on the one hand, and the consonant system in surrounding language forms on the other by stating that the former has replaced the qualitative distinction between hard and soft sounds prevalent to the latter by a new distinction which is gradual or quantitative. If we have to name the two sides of the Swiss opposition of homorganic sounds, the terms fortis and lenis seem best suited.”

92 See Brunner (1953) on occasional voicing. In their empirical study on SwG aspirated stops, Ladd & Schmid (2018) found a significant difference between unaspirated and aspirated *fortis*. Aspiration also occurs, especially in loan words, see e.g. Winteler (1876: 56), Weber (1948: 33), Fleischer & Schmid (2006: 244), Schifferle (2010). ZG has words such as /pːhɒk͡xeːtː/ ‘package’ or /tːheo/ ‘Theo (proper name)’. The phonological status of aspirated stops, however, is questionable. I assume that they are stop + h clusters. It is worth noting, however, that the frequency of such clusters is on the rise.

correlate, a problem that is particularly troublesome for theories that assume that lexical information is interpreted by the phonetic component in a universal manner.

The proposal by Lisker & Abramson (1964) is an early criticism of the observation that *fortis/lenis* lack a clear phonetic basis. They propose to forego *fortis/lenis* altogether. Alternatively, they propound an analysis in terms of Voice Onset Time (VOT). I will present their approach in 3.2. As justified as their criticism on *fortis/lenis* is, VOT offers no explanation for the ZG obstruent system. This also holds for a number of other languages whose alleged *fortis/lenis* contrast cannot be captured by VOT. Drawing on earlier work by Jaeger (1983), I will show in 3.3 that the segmental duration plays a crucial role in such languages.

3.1. *fortis/lenis:* from Winteler to the SPE

Winteler introduced the terms *fortis* and *lenis* in his *Kerenzer Mundart* from 1876, which was the first comprehensive description of a Swiss German dialect. It is probably due to Winteler's pioneering role that the *fortis/lenis* distinction has since become established in Swiss dialectology.

While Winteler (1876: 27) considered intensity the primary factor, he nevertheless mentions that *fortis* and *lenis* also differ in duration, which he calls an "accidental property". In his view, *lenes* and *fortes* differ "with regard to the degree of expiration and articulation energy and duration". *Lenis* consonants are shorter because their articulations "are given up as soon as they reach their peak" while "in the formation of *fortis* consonants, the organs of speech are perceptible in their culmination." As a result, *fortes* are distinguished by the listener "due to the force of the explosive sound and the previous pause".[93]

Winteler's proposal was well received in linguistics. The career of his *fortis/lenis* distinction is indeed remarkable.[94] Nikolaj Trubetzkoy and Roman Jakobson held his

[93] Orig.: "Es sind also zwischen weichen Sprachformen Unterschiede möglich hinsichtlich der accidentellen Eigenschaften der harten und weichen Laute, … hinsichtlich des Masses von Exspirations- und Artikulationsenergie und -Dauer, um welches ihre Lenes und Fortes von einander abstehen. […] diejenigen Artikulationen, welche Lenes erzeugen, [werden] in demselben Augenblicke wieder aufgegeben […], in welchem sie ihre Kulmination erreicht haben. … Bei der Bildung der Fortes verharren die Sprachwerkzeuge fühlbar in ihrer Kulminationsstellung …"

[94] Although *fortis/lenis* had been used in various contexts long before Winteler, I will focus on Winteler's understanding of the distinction because it was his coinage of the term that impacted Swiss dialectology (and modern linguistics in general). See Braun (1988) for a comprehensive historical survey on the *fortis/lenis* distinction. A summary of her research supplemented by more recent phonetic work especially on Swiss German dialects is provided in Willi (1996).

work in high esteem. In his epilogue to Trubetzkoy's *Grundzüge der Phonologie,* Roman Jakobson describes Winteler's work as the "pre-phonological study, Trubetzkoy appreciated most". He quotes Trubetzkoy, who recognises Winteler's systematic account as "remarkable for his time" (Trubetzkoy 1989: 286f.). Jakobson & Halle (1971: 554) honour Winteler as an "outstanding forerunner of modern phonology", and his *fortis/lenis* distinction finds citation in Chomsky & Halle (1968: 324).

It was probably Winteler's treatment of oppositions that made his work so attractive to structuralist (and later generative) phonologists. Trubetzkoy (1989: 14ff.) emphatically points out that phonology is about contrast and phonologists thus study the oppositions in a sound system, disregarding properties that are functionally irrelevant. Winteler's description of the *Kerenzer Mundart* indeed demonstrated a remarkable degree of abstraction. The recognition of the *fortis/lenis* distinction as a basic property to distinguish homorganic sound series thus came close to what phonologists later named distinctive features.[95]

It should be borne in mind, that the fortis/lenis distinction in Winteler's conception is not limited to stops, but also includes fricatives, nasals and laterals. While Heusler (1888) still adheres to this classification, it disappears in later descriptions. Instead, *fortis/lenis* (or strong/weak) is used only for the obstruents. The narrowing of *fortis/lenis* to obstruents not only happened in Swiss dialectology but also in general linguistics. The following overview, therefore, does not cover nasal and lateral sonorants. Moreover, linguistic research seemed to focus mainly on stops.

This shift in definition may already point to the difficulties that accompany Winteler's feature pair. Phonologists have always, at least implicitly, assumed that there is a link between phonetics and phonology. In his system of oppositions, Trubetzkoy (1989: 139f.) describes *fortis/lenis* as a "Spannungskorrelation [correlation of tension]". According to Trubetzkoy, differences in tension result from changes in intraoral air pressure, which in turn are a consequence of the variable tension of the buccal muscles.

Jakobson et al. (1952) incorporated *fortis/lenis* as tense/lax in their catalogue of distinctive features. They describe the opposition as follows:

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95 For a critical review of Winteler's influence on modern linguistics, see Kohrt (1984).

> In consonants, tenseness is manifested primarily by the length of their sounding period, and in stops, in addition, by the greater strength of the explosion.
>
> Jakobson et al. (1952: 36)

Two aspects deserve special mention: first, Jakobson et al. (1952) clearly recognise duration as an essential factor, and second, strength is only assumed for stops.

In a later publication, Jakobson & Halle (1971: 553) discuss the relationship between tense/lax and long/short. They claim that long/short is a prosodic property that should be reserved for vowels. Since consonants cannot be specified for long/short, consonant length must be an epiphenomenon of tense/lax. They furthermore expand the use of the term *fortis/lenis* to languages with a voicing contrast, arguing that voicing is a mere concomitant feature, which can be present (as e.g. in French or Dutch) or absent (as in SwG dialects).

> Fortes are always opposed to lenes by a higher air pressure behind the point of articulation and by a longer duration. This difference may be accompanied by the voicelessness of the fortes and the voicing of the lenes or may lack such concomitant cues.
>
> Jakobson & Halle (1971: 554)

Trubetzkoy's prime interest was the classification of oppositions within a particular language. His work on oppositions was instrumental in understanding the internal organisation of the segment and contributed significantly to the conception of phonemes as feature bundles. Features constitute natural classes, which phonological rules – such as assimilation or neutralisation – systematically apply to. Trubetzkoy's successors continued his work, but they went a step further by attempting to establish a finite set of universal features. The ambitious goal was to define all phonetic features that are phonologically relevant. The ideas advanced by Jakobson and his co-workers smoothly paved the way for Generative Phonology. For their landmark publication *The Sound Pattern of English (SPE),* Chomsky & Halle (1968) largely adopted the inventory developed by Jakobson and others. For their "universal set of phonetic features", Chomsky & Halle (1968: 299) propose the binary feature [± tense], which they classify as a "manner of articulation feature".

In the wake of Jakobson et al. (1952), Chomsky & Halle, too, use the binary feature [± tense] for both vowels and consonants. However, in contrast to Jakobson and his co-workers, who defined distinctions mainly in terms of acoustic properties, Chomsky

& Halle shifted the focus to articulatory properties. In the SPE, they (1968: 325) describe the phonetic correlate of the *tense/lax* distinction as “a greater versus a lesser articulatory effort and duration” with greater articulatory effort being achieved by “greater muscular tension in the muscles controlling the shape of the vocal tract.” Muscular tension thus ensures that the subglottal air pressure and the air pressure in the oral cavity remain equal. This is reminiscent of Trubetzkoy’s above-mentioned “Spannungskorrelation”. Like their predecessors, Chomsky & Halle, too, notice the linkage between the strength of articulation and duration.

The feature pair *fortis/lenis* – or tense/lax – is indeed well suited to capture the opposition in the abstract, but it entails theoretical difficulties. Jakobsonean and subsequent Generative Phonology sought to universally link the phonological component to the phonetic apparatus: features must have a unique acoustic (e.g. Jakobson et al. 1952) or articulatory (e.g. SPE) correlate to process the phonological information.[96] However, several researchers (e.g. Lisker & Abramson 1964; Kohler 1984; Braun 1988) have since pointed out that the universality condition for the feature *fortis/lenis* is difficult to maintain. In fact, various phonetic correlates have been proposed for *fortis/lenis* across languages, raising doubts about universality.[97]

3.2. Alternatives to the feature pair *fortis/lenis* (Lisker & Abramson 1964)

The terms *fortis/lenis* have been used in various linguistic concepts and descriptions. This section gives an impression of the variety of concepts and languages involved. Detailed treatments of the topic are Braun (1988), Jessen (1998), Goblirsch (1994, 2018) and Jansen (2004).

Ladefoged & Maddieson (1996: 95f.) mention the use of *fortis* as “increased respiratory energy”. The best-known example is Korean, where the *fortis* stops occur in “stiff voice”, where “increased subglottal pressure accompanies the more constricted glottis

[96] A second requirement in early generative approaches is that distinctive features must be binary. Thus, a feature can receive either a plus value ‘+’ or a minus value ‘–’. With the development of feature geometry (Clements 1985; McCarthy 1988), however, the binarity condition has been called into question. In particular, there is broad consensus that place features are monovalent. On unary (or privative) features see e.g. Sagey (1986), Clements & Hume (1995), Pulleyblank (1995), Halle et al. (2000). With regard to vowel height, Ladefoged (1975), amongst others, argues for the need to express vowel quality on a multivalued scale. An early examination of privative and multi-valued features can already be found in Trubetzkoy (1989), cf. also 5.1.1.

[97] The universality claim formulated in traditional approaches has lost its absoluteness. Clements & Hallé (2010) provide an overview of how distinctive features are viewed in various theoretical approaches and how the relationship between phonetics and phonology is modelled.

and tenser walls of the vocal tract.” Another – and more frequently used – meaning of *fortis* is articulatory strength. In this sense, *fortis* and *lenis* distinguish two stops series as proposed by Winteler. The fact that there are – at least – two possibilities to implement the phonological contrast directly contradicts the universality claim. Braun’s (1988: 10) careful perusal of the relevant literature reveals that there is little consensus about the phonetic manifestations suggested for [± tense]. Moreover, there is a considerable amount of overlap with related distinctive features such as [± voice] and [± aspirated], which again violates the condition of universality.

Languages that rely solely on the feature *fortis/lenis* are rare. In linguistic descriptions, the distinction is commonly accompanied by aspiration or voicing (or both). Since vocal fold vibration is often absent in [+ voice] consonants, it seemed a convenient solution to set the *fortis/lenis* feature pair as primary. Voicing is thus seen as a concomitant feature that enhances the phonetic difference. Similarly, the absence of aspiration (e.g. in English [st] and [sp] clusters) can be accounted for by an underlying feature [+ fortis (or: tense)]. The assumption is that voice and aspiration are redundant. Being predictable, they are not part of the lexical representation and can be supplied by the grammar by rule. In order to derive the exact phonetic specification in contexts where stops are aspirated, the feature [+ asp][98] is assigned by a redundancy rule.[99]

Early on, the reality of *fortis/lenis* has been called into question by Lisker & Abramson (1964). Their main criticism was that it is used as a purely phonological label without a clear phonetic basis. In particular, they point out that voiced stops are voiced only in certain positions. Word-initial stops often lack vocal fold vibration. Assuming an underlying *fortis/lenis* contrast provides a way out of a problem that is hard to explain with an underlying specification for [voice]. Lisker & Abramson (1964: 386) state that “the phonetic literature generally fails to turn up any language which is said to possess stop categories that differ only in force of articulation”. After reviewing 23 languages, they found that

[98] [± asp] is the feature used in the SPE. More recent work normally describes aspiration by the feature [± spread glottis].

[99] Work in Optimality Theory (OT, Prince & Smolensky 1993) takes a different view. The surface-oriented nature of OT does not evaluate underlying representations (URs). However, the principles of *Richness of the Base* and *Lexicon Optimization* imply that redundant features are included in the lexical representation. *Richness of the Base* claims that inputs are universal and that they are not subject to any language-specific requirements. Therefore, URs are generated with any potential distinctive feature. *Lexicon Optimization* essentially takes a learner’s position. Since lexical representations cannot be accessed directly, learners have to determine them by inference. The principle of *Lexicon Optimization* proposes that in the absence of empirical evidence in favour of one UR or another, a learner will choose the input which matches closest to the winning output candidate. As a result, (formerly) redundant features may become distinctive in the course of time.

> [f]or languages in which the *fortis/lenis* difference is invoked, it is too often the case to be accidental that voiceless and aspirated stops are discovered to be *fortis,* while voiced and unaspirated ones are at the same time lenis.
>
> Lisker & Abramson (1964: 386)

As a consequence, they propose to forego the *fortis/lenis* contrast and, alternatively, they introduce the concept of Voice Onset Time (VOT). VOT measures the time-span from the burst release of the stop to the onset of the voicing of the following vowel. Unaspirated stops have a VOT near zero. Voiced stops have a negative VOT, i.e. the vibration of the vocal cords precedes the release of the closure. Conversely, aspirated stops have positive VOT as the onset of voice is delayed. Maddieson (1984) reports that in his sample, 49 out of 50 languages with a single stop series had zero or short lag VOT. Languages that have two series employ two of the VOT categories, those with a three-way contrast make use of all three VOT categories. In this line of reasoning, the *fortis/lenis* distinction obsolete.[100] Instead, the phonetic implementation of two stop series is captured as follows: 'fortis' stops have a more positive VOT relative to 'lenis' stops. Therefore, the latter is often realised by voicing while the former is reinforced by aspiration.

In his influential work on *fortis/lenis,* Kohler (1984: 150) describes the distinction as "a power feature, realized in articulatory timing and/or phonatory power/tension …" He argues that there is no single articulator that can carry out the contrast on its own. Rather, the phonetic correlate for *fortis/lenis* is a combination of several reinforcement strategies that involve multiple articulators:[101]

> In stops, aspiration and voicing are glottal reinforcements of the fortis and lenis actions at the oral valve to produce the necessary intensity differences in the acoustic signal for a clear category separation in perception.
>
> Kohler (1984: 153)

From the previous sections, two preliminary conclusions can be drawn. First, there is clear indication for a relationship between *fortis/lenis* and duration. Second, Lisker & Abramson (1964) provide evidence that languages that have *fortis/lenis* also have

[100] Lisker & Abramson (1964: 395ff., 403) mention Eastern Armenian and Thai as languages with a ternary distinction. However, the VOT approach encounters difficulties in languages with a four-way contrast (see Chomsky & Halle 1968: 326 on Hindi; similar reservations are expressed in Fulop 1994). For such cases, an analysis in which [± voice] and [± aspiration] can be combined freely seems more favourable.

[101] Kohler (1984: 152ff.) explicitly rules out word-initial contrasts which are solely achieved by the feature [± fortis]. However, if we adhere to the traditional assumption that SwG obstruents (stops) contrast in the feature *fortis/lenis,* they would be a counter-example to this claim.

voicing and/or aspiration. As a consequence, they suggest an analysis in terms of VOT. In ZG, however, *fortis/lenis* is not accompanied by laryngeal features. Therefore, VOT provides no explanation for the contrast in ZG.

ZG is not the only language that cannot be explained in this way. In the following section, I will turn to languages in which *fortis/lenis* was considered a durational contrast.

3.3. *fortis/lenis* as a durational contrast

Comparable to the criticism voiced by Lisker & Abramson (1964), Ladefoged & Maddieson (1996: 96) remark that only a "relatively small handful of languages have been proposed as possibly having articulatory strength differences that are independent of voicing." They mention several Dagestanian languages. However, they seriously question the view that the primary factor is strength. Instead, they argue for a durational contrast:[102]

> Our own impression from the descriptions available of this language [i.e. Archi], and from examination of a tape-recording of three speakers made available by Kodzasov [1977], is that *length should be given the primary role;* strong consonants have approximately twice the duration of weak ones […] The patterns in other Dagestanian languages are similar […]
>
> Ladefoged & Maddieson (1996: 98; emphasis added)

Duration has been proposed as linked to *fortis/lenis* in a series of languages. Ladefoged & Maddieson (1996: 98) cite Ojibwa, an Algonquian language, Zapotec (Otomanguean, spoken in Mexico), Rembarrnga and Djauan (both Australian Aboriginal languages).

Languages that reportedly distinguish *fortis/lenis* without concomitant correlates are a residual group. Jaeger (1983: 184) proposes to separate "VOT languages" from "fortis/lenis languages", the latter comprising languages whose consonant contrasts cannot be explained by VOT differences. Her research on Yatée Zapotec and Jawoñ[103]

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[102] Kodzasov (1977, cited in Ladefoged & Maddieson 1996: 96f.), regards length as a consequence of the greater intensity: "The intensity of the pronunciation leads to a natural lengthening of the duration of the sound, and that is why strong [consonants] differ from weak ones by greater length." Contrary to ZG, however, a sequence of two *lenis* consonants "does not produce a strong one" in Archi. Kodzasov sees this as evidence that "the gemination of a sound does not by itself create its tension."

[103] Ladefoged and Maddison (1996: 98) refer to it as Djauan.

reveals that both languages in fact exhibit voicing, however, voicing applies freely to both, *fortis* and *lenis*. She concludes that

> in languages termed fortis/lenis, there is always reported to be a consistent difference in the duration of the fortis *vs* lenis consonants. […] However, a review of the literature reveals no reliable duration difference in languages with VOT contrasts.
>
> Jaeger (1983: 185)

Swiss German dialects seem to be "fortis/lenis languages" in the sense of Jaeger (1983). VOT is not a reliable cue as the contrast is not one of voicing and/or aspiration.[104] Several phonetic studies have empirically proven that *fortis* and *lenis* consonants do not significantly differ in VOT (e.g. Enstrom & Spörri-Bütler 1981; see Section 6.1). There are, however, measurable differences for segment duration. I will discuss the phonetic aspects in Chapter 6.

As mentioned previously, Winteler, too, acknowledged that *fortis* consonants are longer than their *lenis* counterparts. His view, however, that durational differences are a mere side-effect of the intensity opposition has remained virtually unquestioned in most subsequent dialect descriptions.[105] The following excerpts from eminent grammars of SwG dialects demonstrate this. They simultaneously reveal the close relationship between articulatory strength and consonantal length.[106]

> The two [stop] series are distinguished solely by the degree of strength.
>
> Weber (1948: 33)

> For all fricatives, … we have to distinguish a weak and a sharp degree. The sharp [i.e. *fortis*] fricatives are … about three times as long as the weak ones.
>
> Weber (1948: 34)

> For all fricatives, … we have to distinguish a weak and a sharp degree.
>
> Bossard and Dalcher (1962: 22)

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104 See Ladd & Schmid (2018) on aspiration, cf. fn. 92.

105 A few decades later, Winteler's teacher, Eduard Sievers (1901: 65), still defends the primacy of intensity over duration. For the City of Basle, Heusler (1888: 28ff.) comes to a different conclusion. He notes that while duration seems to accidentally accompany strength in Winteler's vernacular of Kerenz, it is the decisive factor for the vernacular of the City of Basle: "Das Moment, welches in K [vernacular of Kerenz] etc. bloss das accidentielle zu sein scheint …, die Dauer, ist in Bst. [Basel Stadt, vernacular of the City of Basle] das essentielle."

106 The translations are mine, material that was unnecessary was omitted.

> The difference is one of intensity. Consonants with slack articulation are termed *lenis,* while those with tight articulation are called *fortis.*
>
> Baur (1974: 13)

> There is no difference between voiced and voiceless consonants. Swiss German dialects divide them according to degree of strength and quantity. This results in strong and at the same time long consonants, and consonants that are both weak and short.
>
> Fischer (1960: 53)

The examples above indicate that scholars were well aware of the durational differences between *fortis* and *lenis* consonants. Their impression is corroborated by phonetic measurements. A summary of the relevant phonetic studies is provided in Section 6.1.

3.4. Summary

This chapter has attempted to provide a brief outline of the literature relating to the *fortis/lenis* distinction. Starting with Winteler's seminal work on *Kerenzen,* I have shown how he uses *fortis/lenis* and how it has developed in phonological theory. It turned out that *fortis/lenis* was increasingly restricted to obstruents (or stops even), whereas Winteler (and Heusler) also used it for sonorant consonants.

In conclusion, two aspects need special mention. First, it has been shown that the phonetic correlate of *fortis/lenis* is far from clear. This is problematic for a phonological theory that seeks a well-defined relationship between phonetics and phonology. The feature pair has often been brought into play as the primary feature for languages that have other laryngeal features such as voice or aspiration. Criticism of the lack of phonetic basis was voiced early on by Lisker & Abramson (1964), who instead propose a feature VOT. A solution in terms of VOT is not an option for ZG, however. Second, there is a relationship between duration and *fortis/lenis*. In several languages where the contrast cannot be explained by VOT, the duration of the consonant seems to be the deciding factor. This also holds true for the SwG dialects. It is undisputed in Swiss dialectology that *fortis* consonants are longer than their *lenis* counterparts. However, duration was regarded as the effect and articulatory force as the cause. Since experimental studies indicate that duration is the sole phonetic correlate for *fortis/lenis* in ZG, this assumption needs to be revised.

From a phonological point of view, the phonetic findings indicate that the *fortis/lenis* distinction is better understood as an opposition in terms of length. To my knowledge, Haas (1978: 311) was the first to challenge the prevalent view and defined the *fortis/lenis* opposition as a length contrast.[107] His approach is influenced by the work of Bannert (1976) on Bavarian and reflects the [± long] opposition propounded in the SPE. Haas's pioneering work, however, seems to have been ahead of its time. Only recently, linguists (e.g. Goblirsch 1994; Kraehenmann 1996, 2003; Willi 1996; Würth 2002) began to consider the *fortis/lenis* distinction as a contrast between long and short (or geminate vs singleton) consonants. The related phonological implications are the subject of the next chapter.

[107] Orig.: "Ich definiere die Fortis ≠ Lenis-Opposition … als phonologisch relevanten Längenunterschied."

4. Geminates

The previous chapter has shown that the articulatory correlate for *fortis/lenis* is unsettled. With reference to Jaeger's (1983) distinction into VOT languages and *fortis/lenis* languages, I have pointed out that the latter are often characterised by a difference in duration. This suggests that the *fortis/lenis* distinction is, in fact, a length, i.e. a singleton/geminate, contrast.

Early work on geminates includes Sievers (1901), Jespersen (1904), Trubetzkoy (1989 [1939]), and Malmberg (1944). One of the key questions was how and whether long consonants differ from geminates (see Hegedüs 1959 for a research overview). The advent of Autosegmental Phonology (Goldsmith 1976) and the publication of the seminal paper by Schein & Steriade (1986) have made the study of geminates a topic of increasing interest in recent years. Significant contributions are Selkirk (1990), Itô (1986), McCarthy & Prince (1986). There are too many language-specific studies to mention them all at this point. Thurgood (1993) and Muller (2001) survey the topic from a typological point of view. A general synopsis on the state of the art in phonological theory is Davis (2011a). Muller (2001), Topintzi (2006 *et seq.*), and Kraehenmann (2011) focus on the phonology of initial geminates. An evolutionary approach to geminates is offered in Blevins (2004, 2008). A general overview of the phonetics and phonology of geminates is provided in Kubozono (2017a).

This chapter explores the assumption that ZG has a singleton/geminate contrast from a phonological perspective. It is structured as follows: since the meaning of 'geminate' varies among researchers, 4.1 provides terminological clarification. Section 4.2 concerns the phonological representation of geminates. In particular, two predominant theoretical approaches are discussed: Skeletal Theory (or X-Theory) and Moraic Theory. They differ in whether the basic property of geminates is length or their contribution to syllable weight. The former is assumed in X-Theory, the latter in Moraic Theory. A comparison of the two theories is given in 4.2.1. Two aspects which are particularly challenging for Moraic Theory will receive special attention: 4.2.1.1 deals with the question of whether geminates reflect syllable weight as directly as claimed by Moraic Theory. The representation of word-initial geminates is discussed in Section 4.2.1.2. In 4.3, I turn to Zurich German. I will show that ZG in fact has geminates and that they are best captured in Moraic Theory: *fortis* consonants are moraic. Evidence for their moraicity comes from observations of word minimality effects (4.3.1) and some other quantity-related processes (4.3.2). The modelling of ZG word-initial geminates is tackled in 4.3.3. Finally, in 4.4, I discuss the syllabification of geminates and outline the general algorithm I assume for syllabification in ZG.

4.1. On the term "geminate"

Geminates are commonly defined as long consonants (e.g. Kubozono 2017b). Historically, the term encompasses consonants that are a) long, b) tautomorphemic and c) realised heterosyllabically (Sievers 1901).[108] While there is little controversy on the first two conditions, the heterosyllabicity requirement has been challenged over the last decades. Phonological theory developed a conception that deviates significantly from the traditional notion of geminates, in particular, the term has been extended to refer to consonants at word edges.

With respect to the second criterion that demands geminates to be tautomorphemic, a general division can be made between lexical – or "true" – geminates, and so-called "fake", or "false", geminates. Lexical geminates contrast with singletons in the phonology of a particular language. Fake geminates, on the other hand, are sequences of accidentally identical segments that result from morpheme concatenation, such as *roommate*. They also occur in languages that lack a phonological singleton/geminate contrast. A particular type of heteromorphemic geminates are those that emerge through assimilation processes, such as *immoral*.[109]

[108] From an articulatory viewpoint, it is reported that medial geminates have two peaks that result from two independent articulatory gestures, an idea going back to Sievers (1876). This seems to be the case in Estonian (Lehiste et al. 1973), however, several studies on other languages could not find any such behaviour (e.g. Smith 1995; see also Ladefoged & Maddieson 1996: 92f.). It would be beyond the scope of this thesis to give a full account of Sievers's elaborate distinction between *Schallsilben* and *Drucksilben*. It is noteworthy, however, that his assumptions about the nature of geminates, at least in German linguistics, were of great impact. In Sievers's (1901: 212) conception, geminates were not only heterosyllabic, they were also "double-peaked" because "the ear indeed perceives two separate sounds" ["das Ohr hier wirklich zwei getrennte Laute zu vernehmen glaubt"]. This assumption was in part confirmed by Dieth & Brunner (1943), it was, however, rejected later (see Willi 1996 for a detailed discussion).

[109] There is no general consensus as to whether geminates which are the result of assimilation should be considered "fake" or "true". Dmitrieva (2012: 8) opts for the latter, while Oh & Reding (2012) regard them as a special case of fake geminates. From a phonological viewpoint, an analysis as true geminates implies that they behave like true geminates.
ZG has ample examples of assimilated geminates (cf. 2.4.1), however, there is a tendency to avoid fake geminates in certain affixation contexts. For instance, words ending in [l] do not result in a fake geminate when the diminutive suffix *-li* is attached (e.g. /muːl/ 'mouth' – /myːli/ 'mouth (dim.), cf. Weber 1948: 327); furthermore, geminate *r* is avoided throughout, cf. 2.3.2.3. Some studies on Swiss German dialects have focused on assimilated geminates (Fulop 1994) or incorporated them into their analyses (Ham 1998). I will not pursue the matter any further here, as the data used in the present thesis deliberately excluded both concatenated as well as assimilated geminates.

In this dissertation, the term 'geminate' is used for consonants that phonologically contrast with 'singleton' consonants. As I will lay out momentarily, Moraic Theory defines geminates as inherently moraic. I will adhere to this definition throughout this thesis. In this conception, geminates are not restricted to heterosyllabic contexts. They may as well occur at the word margins.

Typologically, geminates occur only in a minority of languages and are the most common intervocalically (Thurgood 1993; Muller 2001; Kraehenmann 2011). Most languages with geminates, therefore, conform to the heterosyllabicity condition. Word-final geminates are more frequent than word-initial geminates. They are preferred in post-tonic environment after short vowels. According to Muller's (2001) cross-linguistic survey on the nature of geminates, the most frequent places of articulation are coronal and labial, and the most frequent manners of articulation are obstruents and nasals.[110] Regarding the length criterion, it has been stated and confirmed by many that the primary correlate of geminates is duration. Ladefoged & Maddieson (1996: 92) report that the ratio between singletons and geminates ranges from 1:1.5 to 1:3. These findings are confirmed by Hamzah et al. (2016), who provide an excellent overview of the recent literature on geminates. They (2016: 138) report singleton/geminate ratios ranging from 1.45 (Cypriot Greek) to 3.4 (Malayalam) in word-medial position and from 1.25 (Cypriot Greek) to 2.83 (Pattani Malay) word-initially. The variation occurs cross-linguistically as well as language-internally depending on manner and place of articulation of the respective sounds.

4.2. On the representation of geminates

Early generative work attempted to represent length in purely segmental and linear terms. Chomsky & Halle (1968) proposed the distinctive feature [± long].[111] This approach, however, turned out to have some major drawbacks that led to a reintroduction of prosodic categories (e.g. Leben 1980; Clements & Keyser 1983). The linear approach proposed in the SPE is inadequate, mainly for two reasons. First, it does not sufficiently recognise that geminates sometimes behave like two segments

110 As regards the sonority of geminates, some implicational universals have been proposed (cf. Zec 1988, 1995; Thurgood 1993; Podesva 2002). See, however, Blevins (2004, 2008) for a critical review. A further development of the typological findings, especially with regard to sonority, is provided in Morén (1999).

111 This view has been adopted by Haas (1978: 311ff.) for SwG, see 4.3.

and sometimes like a single segment. Second, deleting a segment often leaves a trace that is inexplicable in a purely segmental account. I will discuss both points of criticism below.

Geminates often show a hybrid behaviour, sometimes acting like clusters and sometimes patterning with single phonemes. Prince (1984: 239) illustrates this with an example from Finnish. His line of reasoning can be transferred directly to Zurich German.

ZG permits word-medial consonant clusters when they are preceded by a short vowel (46)a). Clusters are prohibited after long vowels, diphthongs, and vowel + sonorant sequences, (b). However, the restriction does not hold for geminate consonants (c).[112]

(46)	a.	[ʃʊɒlpə]	‘swallow’	b.	*[ʃʊɒːlpə]
		[ʋintə]	‘attic’		*[ʋiə̯ntə]
		[pːɒlmə]	‘palm tree’		*[pːæu̯lmə]
		[tːɒksi]	‘taxi’		*[tːɒlksi]
	c.	[lumpːə]	‘cloth’		
		[tːolkːə]	‘stain’		
		[tæu̯fːi]	‘baptism’		
		[ræu̯pːə]	‘caterpillar’		
		[fløːtːə]	‘flute’		

The distribution in (46) shows that geminates and singleton consonants pattern together to the exclusion of consonant clusters. Thus, geminates behave like single consonants, suggesting the specification [+ long]. However, such an analysis falls short when we take the syllabification of word-medial geminates into account. Following standard assumptions on sonority, consonant clusters with decreasing sonority are heterosyllabic.[113] Thus, (47)a) would be syllabified as [kum.fi]. In (b), on the other hand, the medial fricative may only straddle the syllable when analysed as a sequence of two segments. If it were specified as a single [+ long] segment, it would be syllabified entirely in the onset. This is an undesired syllable structure because ZG does not exhibit word-initial geminate fricatives.[114]

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112 Prince (1984) notes for Finnish that word-medial three-member clusters are permitted when the middle consonant is [s]. ZG displays a similar pattern, the medial consonant being [ʃ], e.g. [hɒmʃtər] ‘hamster’, [polʃtər] ‘upholstery’, [oːʃtərə] ‘Easter’.

113 See e.g. Murray & Vennemann (1983), Selkirk (1984a), Vennemann (1988), Blevins (1995), Zec (2007). A recent overview is Parker (2011). On the sonority scale assumed for ZG, see (95).

114 See 2.3.1. One may object that syllables containing schwa as (47)b) are exceptional. This has been pointed out by Kager & Zonneveld (1986: 219) who note that in Dutch “schwa seems to behave as a word boundary”. They argue for an appendix for schwa-initial syllables. In fact, ZG schwa, too, appears to allow preceding material that is prohibited elsewhere (e.g. velar

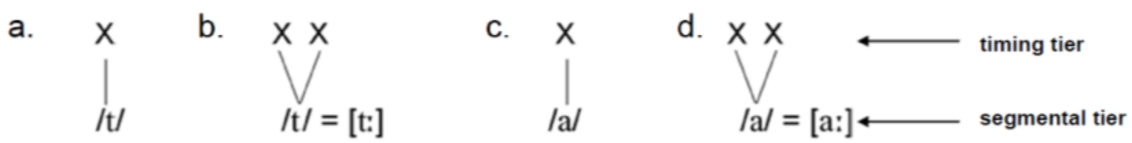
(47) a. [kumfi] ‘jam’
b. [ʋɒfːə] ‘weapon’

The above examples illustrate the strangely hybrid status of geminates. (46) calls for a monosegmental analysis of geminates, with geminates specified for [+ long]. Conversely, we would expect a heterosyllabic structure in (47). This suggests a bisegmental analysis where geminates are considered two consecutive segments with the specification [- long].

With the advent of Autosegmental Phonology (Goldsmith 1976), length was no longer considered a feature. Instead, it is represented on a separate tier, which is linked to the segment by association lines. Goldsmith developed the autosegmental analysis predominantly for African tone languages. A key insight was that tone is independent of the segment. Accordingly, the loss of the vowel does not necessarily entail the loss of its tone. A representation of tone and segment on independent phonological tiers thus seemed more appropriate.

For vowel and consonant length, there is also evidence that length is not a property inherent to the segment. I will address this aspect momentarily. Let us first clarify the relationship between segment and higher prosodic structure. In an autosegmental representation, segments are linked to an element that acts as an intermediary between the segmental level and the syllable.

In X-Theory (Levin 1985), segments are associated with a timing unit (so-called “X position”) on the timing tier. The structures are given in (48). Singleton consonants and short vowels are single segments on the melody (segmental) tier and are linked to a single X position (a, c). Geminates and long vowels are also single segments on the segmental level. On the timing (skeletal) tier, however, they are linked to two positions (b, d).[115]

(48)


nasals). However, fricative geminates also appear in (loan) words ending in a full vowel, e.g. [ˈmɒfːiɒ] ‘mafia’, [ˈtːoːfːu] ‘tofu’, [ˈsoːfːɒ] ‘sofa’, [ˈlɒsːo] ‘lasso’, as well as proper names such as [ˈsofːi] ‘Sophie’, [lɒˈrisːɒ] ‘Larissa’.

115 /t/ and /a/ are placeholders for any consonant and vowel, respectively. As an abbreviation, they stand for a hierarchically ordered feature tree (Clements 1985; Clements & Hume 1995).

The advantage of the two-level representation is that phonological processes can refer to either the melodic level or the skeletal level, or both. This elegantly accounts for the seemingly paradoxical behaviour of geminates. In their seminal paper, Schein & Steriade (1986) establish two main characteristics of geminates:[116]

(49) Inseparability: Geminates must not be split by epenthesis
Inalterability: Phonological processes always affect the whole geminate

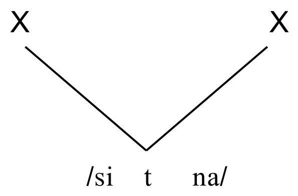
For *Inseparability,* consider the data in (50) from Palestinian Arabic (cf. Abu-Salim 1980; Hayes 1986):

(50)	a.	/ʔakl-kum/	[ʔakil-kum]	‘your food’
	b.	/samak kbiːr/	[samakikbiːr]	‘big fish’
	c.	/sitt-na/	*[sititna]	‘our grandmother’

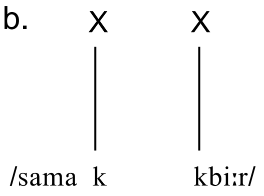
Palestinian Arabic has epenthetic [i] that is regularly inserted to avoid consonant clusters (a). Vowel-insertion also takes place to split two identical consonants at morpheme boundaries (b). In the case of true geminates (c), however, epenthesis fails to appear as predicted by the *Inseparability Constraint* in (49).

Autosegmental Phonology captures the difference between true and fake geminates by different representations, illustrated in (51). While true geminates consist of a single root node associated with two positions of a higher prosodic unit, fake geminates are represented as a sequence of two separately linked root nodes.

(51) a.



b.



The *Inseparability Constraint* is closely connected to the *No Crossing Constraint* (Goldsmith 1976), stating that association lines may not cross. Epenthesis in (51)a) would violate the constraint. Thus, while the insertion of a vowel does not affect the association lines of singly linked consonants (52)b), they illicitly cross the association line of the geminate (a).

116 For inseparability see also Kenstowicz & Pyle (1973: 42) who note that epenthesis rules do not apply with geminates “if their application would result in the separation of a geminate cluster from its twin.” An earlier version of inalterability is Hayes (1986).

(52)

It should be noted that a segmental specification as proposed in the SPE has no difficulty in separating true geminates from fake geminates either. The latter is a sequence of two segments specified for [- long], while the former is a single segment with the specification [+ long], thus logically inseparable. However, the analysis faces problems as soon as there are additional contexts in which geminates pattern with clusters. A multiply linked representation can refer to either level. Geminates are single elements on the melody tier, but they are not on the timing tier.

An example of *Inalterability* is the spirantisation rule in Tigrinya (Kenstowicz 1982). Spirantisation affects postvocalic velar stops. We thus find alternations like [kəlbi] 'dog' vs [ʔa-xalɨb] 'dogs'. On the other hand, [fəkːərə] 'he boasts' escapes the spirantisation rule yielding neither *[fəxːərə] nor *[fəxkərə]. This demonstrates that rules may fail to apply to geminates, and they fail to apply completely, thus ruling out half-spirantised clusters such as *[fəxkərə].[117] The Tigrinya spirantisation rule refers to the underlying structure of geminates assumed in Skeletal Theory: only singly linked root-nodes as in (48)a) undergo spirantisation.[118]

One of the most convincing arguments for an autosegmental analysis that posits intermediate nodes between segments and the syllable comes from Compensatory Lengthening (CL) and related phenomena. The key observation is that the deletion of a segment is often accompanied by the lengthening of another segment. Consider the diachronic change from Indo-European **casnos* to Latin *cānus* 'dog' (Hayes 1989: 260f.), illustrated in (53). In X-Theory, the process can be represented as the deletion

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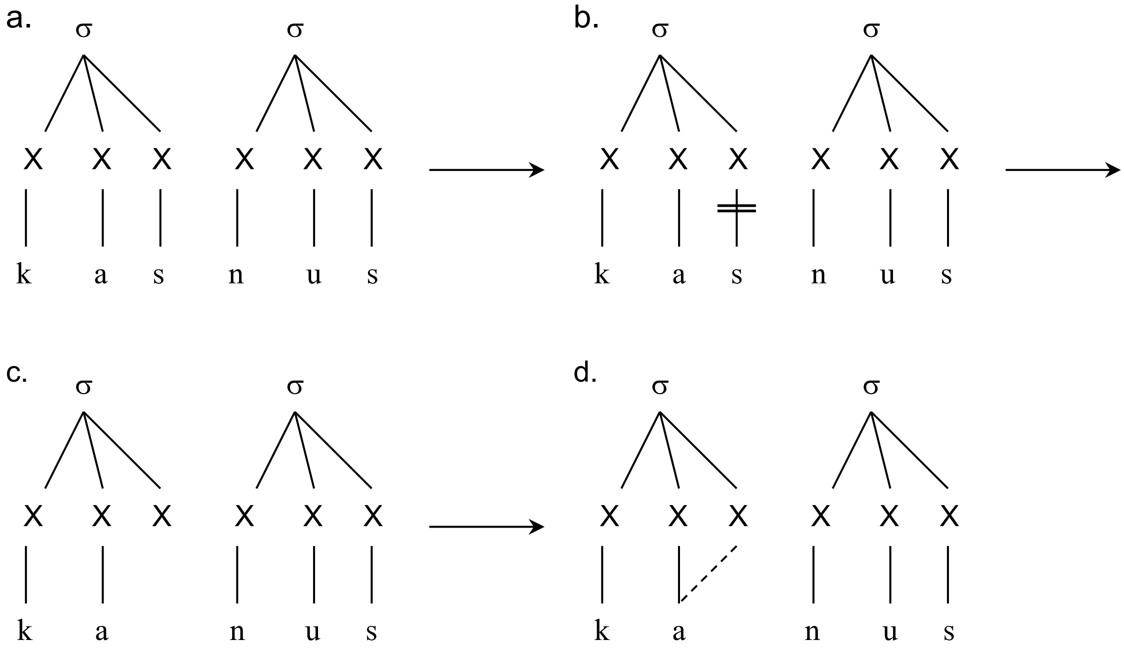
117 The assumption of general geminate inalterability has been challenged in subsequent work, however (cf. Inkelas & Cho 1993; an overview is provided in Kirchner 2000). Drawing on earlier work by Churma (1988), Kirchner (2000) proposes that geminate inalterability is universally inviolable only for lenition processes. His analysis, which focuses on the lenition of stops, makes a distinction between "half-spirantization … and half-gliding" (p. 515). For the latter, see Loporcaro (1996: 153) on Piedmontese Italian, where the first half of a lateral geminate is palatalised; Schlote (2008: 192) shows that in Bernese, the second half of the vocalised geminate lateral is an approximant. The OHG consonant shift provides another interesting case, as medial geminate stops underwent affrication. Kirchner (2000: 514) does not view this as a counter-example since affrication was not restricted to geminates but also applied to singleton stops. He argues that affrication in OHG is not a lenition process, rather it "is (perceptually driven) fortition".

118 This condition is formulated in the *Linking Constraint* (Hayes 1986: 331): "Association lines in structural descriptions are interpreted as exhaustive." A similar, yet more restrictive constraint is the *Uniform Applicability Condition (UAC),* Schein & Steriade (1986: 727).

(delinking) of a segment on the melody tier (b) leaving an unassociated X position on the skeletal tier (c) which is ultimately reassigned to the preceding segment (spreading) (d).

(53)



In an autosegmental account, CL is viewed as an instance of conservation of the unit on the skeletal tier and can be explained straightforwardly: the loss of the consonant leaves a stranded X position. Instead of being erased, delinked timing slots are retained and filled with new content by the spreading of an adjacent segment. A linear account is unable to express the relationship between segment deletion and lengthening directly.

4.2.1. Length vs weight

Among phonologists, there is broad agreement that an autosegmental representation of geminates must be preferred over linear approaches. However, there is no consensus on whether geminates should be represented by length or by weight. The former is advocated by researchers that support a skeletal approach,[119] the latter is put forward by Moraic Theory (Hyman 1985; Hayes 1989).

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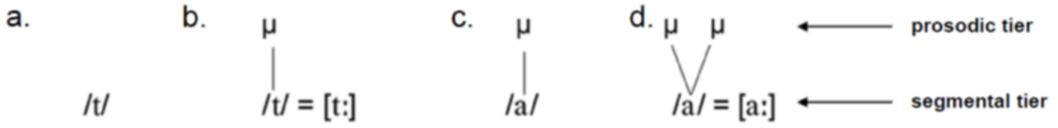
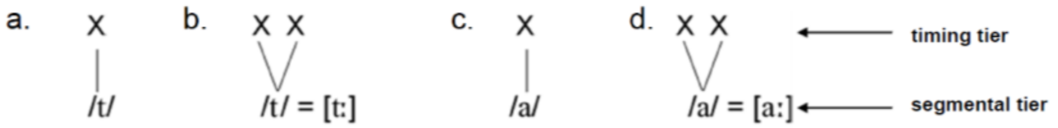
[119] There are two prevailing views on the shape of the skeleton, both of which assume an intermediate level – the timing tier – to link segmental information to higher prosodic levels. The CV model (McCarthy 1979; Leben 1980; Clements & Keyser 1983) and the X-slot model (Levin 1985; Lowenstamm & Kaye 1986). In CV theory, skeletal positions are specified as [± syllabic] and consonants and vowels are organised on separate tiers. X-Theory dispenses with such a distinction and associates every segment as X on the timing tier while enriching the internal syllable structure by additional nodes (rhyme, coda). See e.g. Broselow (1995) for an overview.

Like skeletal theories, Moraic Theory, too, assumes two levels of representation to capture the difference between singletons and geminates. The prosodic unit that links the segmental and the syllabic tier is the mora. The relevant structures are schematically given in (54). For comparison, the respective structures in X-Theory are repeated in (55).[120]

(54)


(55)


Comparison between (54) and (55) reveals that unlike X-Theory, Moraic Theory employs different structures for underlying geminates and long vowels: vowels are always mora-bearing, short vowels are monomoraic (c), and long vowels are bimoraic (d). As for the consonants, only geminates are moraic (b). The relationship between X positions and segments is essentially iconic, i.e. the number of X-slots largely corresponds with the number of segments. The prosodic tier in Moraic Theory, on the other hand, does not reflect segment count. Instead, it determines the contribution of a segment to syllable weight by introducing the notion of the mora – a unit traditionally used in poetics to distinguish heavy from light syllables.

If we look at the consonants, the main difference between the two representations is that in Moraic Theory, geminates are underlyingly associated with a mora and are therefore inherently weight-bearing.

While skeletal models directly mirror the durational differences between singletons and geminate consonants on the timing tier, the relation between weight – i.e. moraicity – and length is not straightforward in Moraic Theory. Also, the heterosyllabic syllabification of geminates falls out naturally in X-Theory under standard assumptions of sonority. In Moraic Theory, too, intervocalic geminates surface as heterosyllabic. However, this is viewed as an epiphenomenon of a) syllable structure preferences and

[120] The model adopted here is the “standard” model developed by Hayes (1989). Hayes’s (1989) main argument against skeletal theories is that they fail to straightforwardly explain why the loss of onset consonants does not trigger compensatory lengthening (see below). His argument crucially relies on the assumption that onsets are nonmoraic; cf. however, Topintzi (2008, 2011), Topintzi & Davis (2017) for a different view.

b) the requirement that moraic consonants must be syllabified in the coda to keep their moraic value. As a consequence, geminates straddle the syllable boundary to prevent onsetless syllables:

> I assume that an underlying geminate (one mora) … has its consonant melody "flopped" onto a following vowel-initial syllable. This creates an onset (hence a preferred syllable structure) without disrupting moraic value.
>
> Hayes (1989: 257f.)

Heterosyllabicity is not a prerequisite for geminates, as can be seen in the case of word-final geminates. The structural difference between singletons (a) and geminates (b) is shown in (56).[121]

(56) a. b.

Hayes (1989: 257) notes that the "surface double linking of a geminate is derived by the rules of syllabification … and is not present in underlying forms, as in segmental prosodic theories." This means that consonants exhibiting a flopping structure never contrast with moraic consonants that are singly linked. The syllabification algorithm that results in a "flopping" structure as proposed by Hayes (1989: 259) is given schematically in (57). For comparison, (58) provides the derivation of the nonmoraic counterpart. It proceeds as follows: first, syllables are assigned to vowels. Second, consonants are associated with the following syllable. Note that in the case of geminates (57) the association line goes directly from the segment to the onset. And lastly, the mora is adjoined to the preceding syllable.[122]

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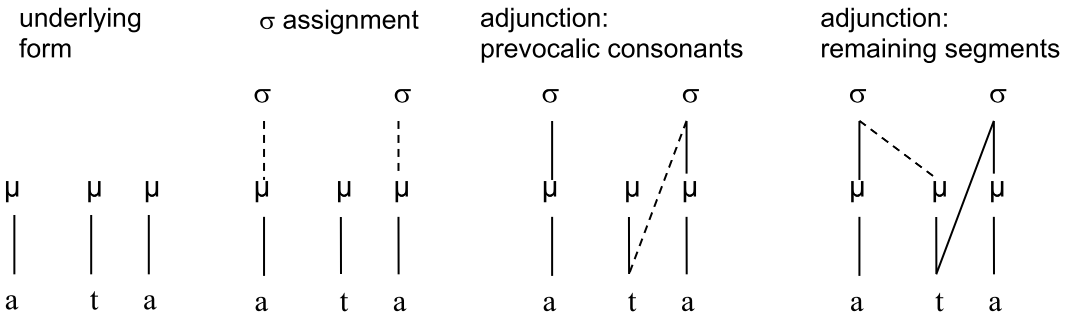
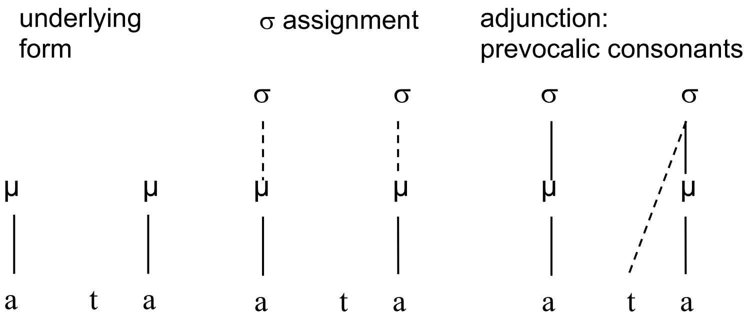
[121] In fact, the locus of adjunction of non-moraic elements is widely debated and presumably language-specific. I adopt Hayes's (1989) representation, here. With respect to the Strict Layer Hypothesis (SLH, cf. Selkirk 1984b; Nespor & Vogel 1986), one would expect them to be adjoined at the lowest level possible. On the violability of the SLH see Itô & Mester (1992). Spaelti (1994) argues that final consonants should have as little prosodic structure as possible.

[122] Hayes (1989) proposes the surface forms [atːa] for (57) and [ata] for (58), respectively, which suggests that the flopping nature of moraic consonants triggers phonetic length.

(57)



(58)



The main difference between Moraic Theory and X-Theory is that the former is not primarily about length contrasts, but weight contrasts. In skeletal models, the weight of the geminates is not part of the underlying structure. Instead, X-Theory invokes subsyllabic constituents (rhyme, nucleus, coda).[123] Differences in syllable weight are derived from the structure of these constituents. In X-Theory, syllables count as heavy if either the nucleus or the rhyme branches.

Moraic Theory aims to explain prosodic processes (such as stress assignment, compensatory lengthening, word minimality) in a unified manner. The phonetic realisation of a segment plays a subordinate role. Geminates are interesting for Moraic Theory only because they are underlyingly moraic.

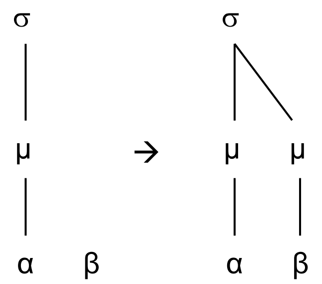
The mora is the basic unit of Moraic Theory. Vowels and geminates are associated with moras in their underlying representations, as shown in (54). They contribute, so to speak, "by nature" to the syllable weight. However, there are also segments that contribute to syllable weight due to their position in the syllable. Evidence comes from a large number of languages that treat closed syllables as heavy. For instance, Latin stress is on the penult if heavy and on the antepenult if the penult is light. Thus, we have penult stress in *fortūna,* where the vowel is long, and antepenult stress in *digitus.* The penult also receives stress when it is closed by a consonant, e.g. *profundum,* suggesting that the coda consonant in the penult contributes to syllable weight.

---

[123] Note that I make use of these labels for a heuristic purpose only.

In Moraic Theory, postvocalic coda consonants can be assigned a mora by the rule of Weight-by-Position (WbP, Hayes 1989). WbP is a language-specific rule that requires coda consonants to be moraic, cf. (59):

(59) Weight-by-Position (cf. Hayes 1989: 258)



As an intermediate summary, we can state that consonants in Moraic Theory can be moraic for two reasons. Geminates, on the one hand, are inherently moraic. On the other hand, singleton consonants can be moraic because of their position. In contrast to lexical (inherent) moras, moras assigned by WbP are *structural* moras, and the mapping follows an algorithm.[124]

Languages differ in whether they count closed syllables as heavy or as light. Weight-by-Position is thus considered parametric (Hayes 1989; Zec 1995). Furthermore, there is variation between languages with respect to which consonants are weight-contributing when in coda position. This can be achieved by placing language-specific restrictions on the Weight-by-Position rule.[125]

The main argument in support of an analysis in terms of the mora comes from lengthening processes. Let us reconsider Compensatory Lengthening, previously illustrated in (53). Given the assumptions of Moraic Theory, the lengthening of the preceding vowel falls out naturally. The deletion of elements that are weight-contributing is accompanied by the lengthening of an adjacent segment (normally a vowel), in order keep the weight of the syllable constant. Thus, with the deletion of the

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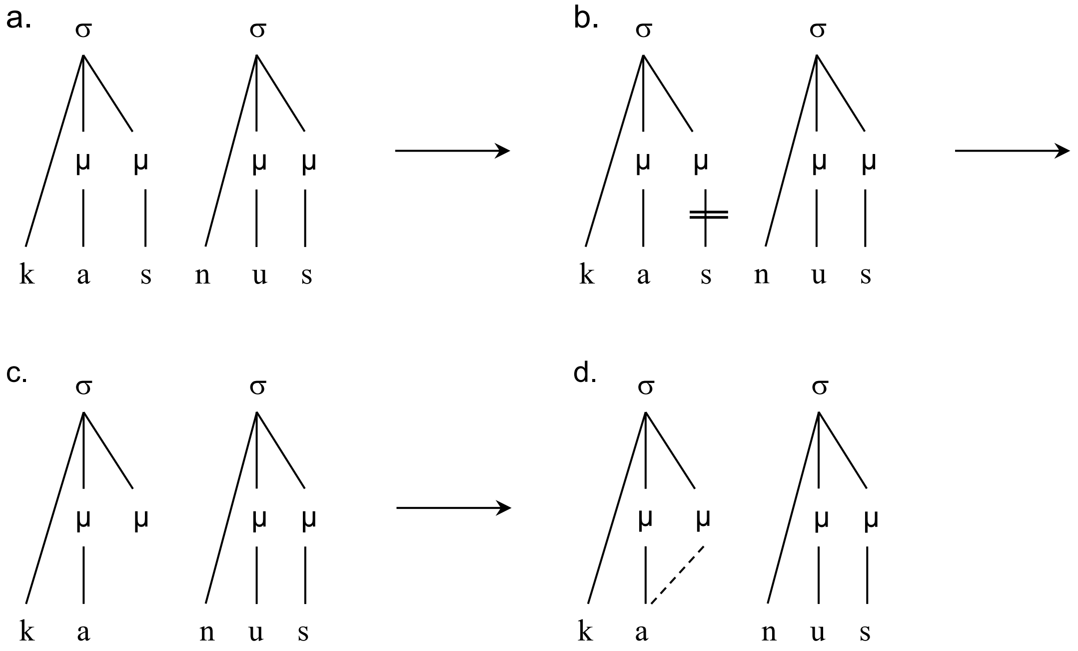
[124] As I have done in Würth (2002), I use the labels ‘structural’ and ‘lexical’ in analogy to the terminology in Case Theory, where structural case is assigned in a certain structural configuration, as opposed to lexical case, which is lexically specified. Lexical vs structural moraicity corresponds to Morén’s (1999) distinction between *distinctive* vs *coerced* weight. I will resume this discussion in 5.2.4.1.

[125] Cf. e.g. Hyman (1985), Zec (1988, 1995), Morén (1999). Zec (1995) demonstrates the close relationship between sonority and moraicity: the higher a segment is on the sonority scale, the more likely WbP applies. In fact, Zec (1988, 1995) proposes that the moraicity of a segment implies the moraicity of any more sonorous segment class. Nonetheless, it is quite uncertain whether this generalisation holds for ZG, as /r/ apparently escapes mora assignment despite high sonority. However, there are some instances where syllables closed by /r/ receive stress: [inˈfɛrno] ‘inferno’, [pɒˈlɛrmo] ‘Palermo’, [lɒtˈtɛːrnə] ‘lantern’, [k͡xɒˈsɛrnə] ‘barracks’.

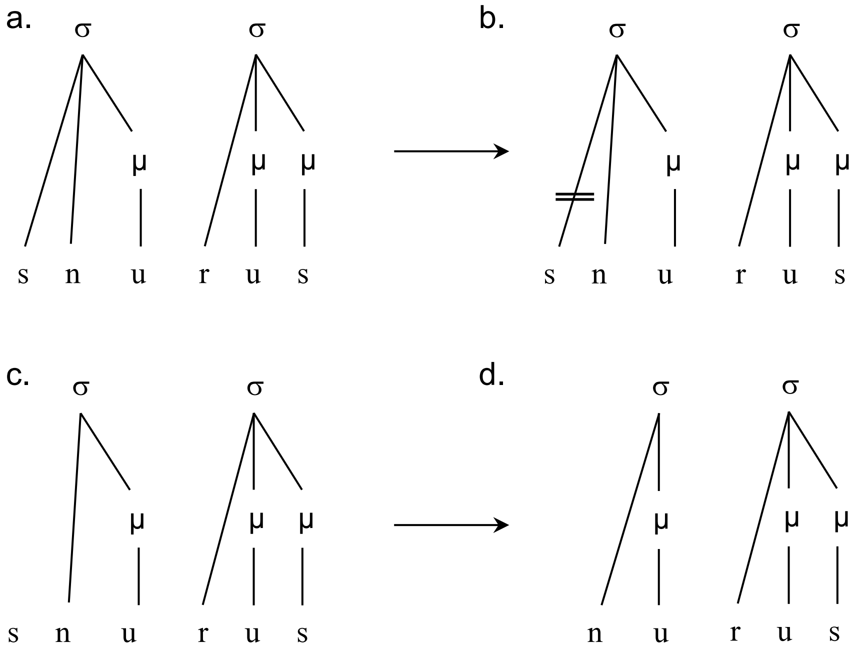
coda consonant, the (structural) mora is delinked and must be reassociated with the preceding vowel, cf. (60):

(60)



As a consequence, lengthening fails to appear when the deleted consonant does not contribute to syllable weight. Hayes (1989: 262f.) gives the example Indoeuropean **snurus* > Latin *nurus* ‘daughter-in-law’, (61). Other than in (60), the deletion of the sibilant does not trigger lengthening and the stray consonant is erased without leaving a trace.

(61)



Based on these observations, Hayes (1989) makes the strong prediction that onset consonants do not trigger CL. This is a direct consequence of the assumption made in Moraic Theory that onsets do not contribute to syllable weight.[126]

A second example in support of Moraic Theory is the sound change illustrated in (62): Early Middle English CVCV words become CVVC as a result of schwa apocope (Minkova 1982).

(62) Early ME /tale/ > ME /taːl/ (> Modern English /teɪl/)

The exact analysis provided by Hayes (1989) is somewhat intricate. However, the main line of reasoning is obvious: as schwa was dropped, the mora previously associated to schwa was left over and was relinked to the preceding vowel. Again, lengthening is a direct consequence of mora conservation.[127]

A third piece of evidence comes from word minimality. Hawaiian (Morén 1999: 162ff.) has distinctive vowel length, whereas consonant length is not contrastive. As shown in (63), Hawaiian allows CV syllables (a). However, words that consist of a single CV syllable are ruled out (b). Monosyllabic words containing a long vowel, on the other hand, are permitted (c).

(63)	a.	[nana]	‘to plait’
		[naːna]	‘by him’
		[nanaː]	‘to snarl’
	b.	*[ko]	
	c.	[eː]	‘different’
		[paː]	‘fence’
		[koː]	‘sugar cane’

The examples above indicate that Hawaiian imposes a minimum size on words: content words must be minimally bimoraic. It is irrelevant if this requirement is met by two light syllables or a single heavy syllable. A major advantage of Moraic Theory is that the similar patterning of CVCV and CVV (to the exclusion of CV words) is straightforward: “at the level of the mora, CVCV is equivalent to a single heavy syllable” (Broselow 1995: 197).

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126 The validity of this claim has not been left uncontradicted, however (see Topintzi 2006, 2008). I will come back to initial consonants in Moraic Theory in 4.2.1.2.

127 There is a general assumption that stray moras are reassociated with vowels rather than consonants (Kenstowicz 1994: 434), however, the reverse is also documented, e.g. Clements (1986: 64) for Luganda. See Gess (2011) for an overview of compensatory lengthening.

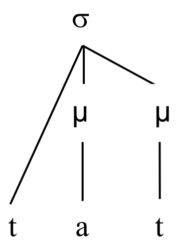
The fact that Moraic Theory has two types of moraic consonants raises the question of whether segments that are assigned a mora by position can be distinguished from geminates. Hayes puts emphasis on the “dual role” of the mora in Moraic Theory:

> First, it represents the well-known contrast between light and heavy syllables: a light syllable has one mora, a heavy syllable two. Second, the mora counts as a phonological position: just as in earlier theories, a long segment is normally represented as being doubly linked.
>
> Hayes (1989: 254)

Thus, moraic consonants can be doubly linked or singly linked. In the latter case, the mora may be inherent or structural. Regarding quantity-related phenomena, moraic consonants behave the same regardless of their origin. However, with respect to the syllable structure, geminates are heterosyllabic in the appropriate word-medial contexts. That is, they have a doubly linked (or flopping) structure that is interpreted as length.

Let us now turn to word-final geminates. Consider the representation in (64) below.

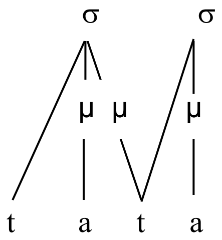
(64)



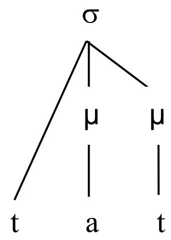
(64) can be interpreted in two ways: the mora of the final consonant can either be inherent or assigned by Weight-by-Position. The prediction is that in a structure like (64) singleton consonants cannot be distinguished from geminates. The contrast between singletons and geminates is neutralised (unless there are special devices that preserve it).

In summary, Moraic Theory differs from X-Theory in that the former is concerned about quantity-related phonological processes. The essential unit is the mora. Geminates are inherently moraic, whereas singletons are moraless. Depending on the environment, geminates may occur as doubly linked or as singly linked structures. Singletons in coda position can be assigned a mora via WbP. Onsets are considered non-moraic. The relevant structures are summarised below. Two aspects are crucial here: first, geminates can manifest in two ways, and second, a singly linked geminate cannot be distinguished from a singleton that is assigned a structural mora.

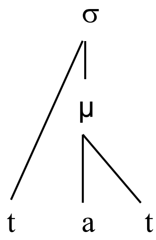
(65) doubly linked geminate



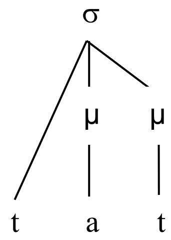
singly linked geminate



non-moraic singleton



structurally moraic singleton



4.2.1.1. Criticism on Moraic Theory I: Principle of Equal Weight (Tranel 1991)

The representation of geminates as inherently weight-bearing makes some very strong predictions. First, it predicts that in quantity-sensitive languages, syllables containing a geminate are automatically heavy. This view has been challenged by a number of linguists, most prominently by Lahiri & Koreman (1988), Selkirk (1990) and Tranel (1991), and more recently, Ringen & Vago (2011). Tranel (1991: 293ff.) points out that in several languages that do not have Weight-by-Position, all closed syllables pattern as light, including those that are closed by a geminate. For such languages, Moraic Theory makes the wrong predictions. (66) illustrates the problem with relevant data from Selkup. Note that Selkup is weight-sensitive for stress assignment, syllables containing a long vowel count as heavy. The distinction between light and heavy syllables in Selkup can thus be determined from stress placement: stress falls on the rightmost heavy syllable or else on the initial syllable.[128]

Moraic Theory rightly predicts stress for (66)a) and (b). Long vowels are bimoraic making the syllable heavy. WbP is parametric and Selkup coda consonants are moraless, thus, the stress shifts to the initial syllable. The problematic structure is (c). Since geminates are inherently moraic, the velar stop in (c) should render the penult bimoraic. However, stress again falls on the initial syllable giving rise to the assumption that all CVC syllables pattern alike.

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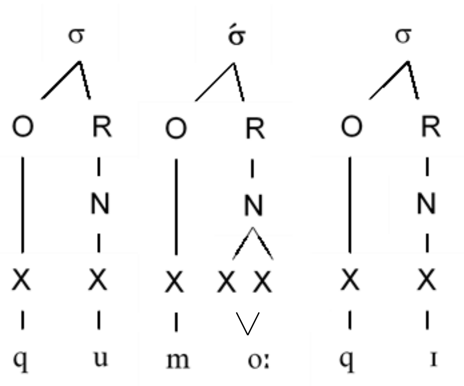
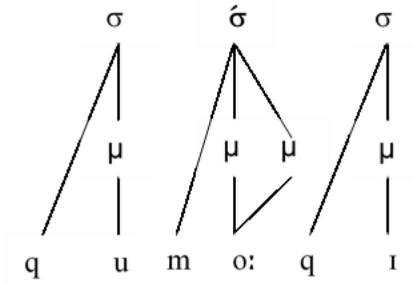
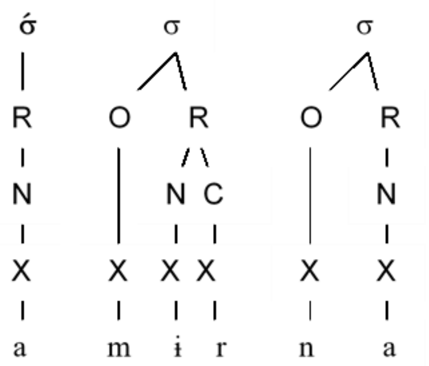
128 The examples are taken from Ewen & van der Hulst (2001: 157).

(66) a i.

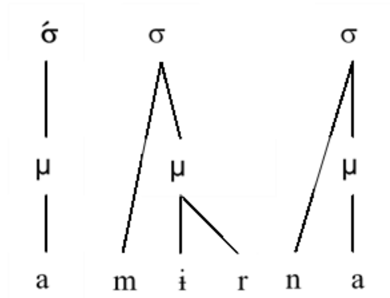




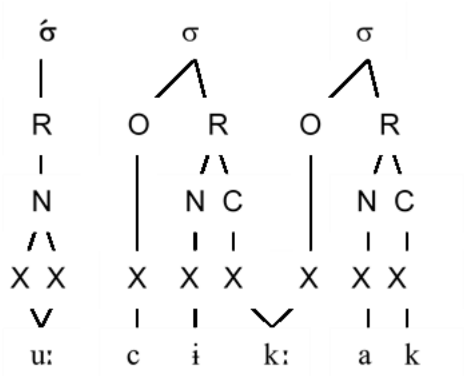
b i.



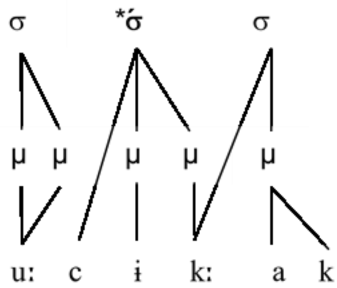
ii. ‘eats’



c. i.



ii. ‘I am working’



The stress pattern of Selkup is, of course, severe evidence against the lexical assignment of moras to geminates. X-Theory, on the other hand, does not face such problems. On the timing tier, the first X position of a geminate has the same status as a singleton consonant. Regardless of whether the closing X-slot is a singleton or the first part of a geminate, they both constitute CVC syllables with a branching rhyme. Furthermore, the splitting of the rhyme in subrhymal nucleus and coda allows direct reference to the respective constituent in the structural description. Hence, quantity-sensitive languages that make exclusive reference to the nucleus can be described accordingly. They are nucleus-weight languages, i.e., languages where only branching nuclei make a syllable heavy.[129]

[129] I adopt the term from Ewen & van der Hulst (2001: 134ff.) who refer to Hayes (1995: 51).

The structural similarity of the penults in (66)b) and (c) cannot be reflected in Moraic Theory. Rather, (c) patterns with (a) as they both have two moras. Moraic Theory thus makes the wrong prediction for (66)c) that stress falls on the penult. X-Theory, on the other hand, rightly predicts initial stress. The difference between light and heavy syllables is determined by the structure of the nucleus: Selkup syllables are heavy *iff* the nucleus branches.

In a similar vein, Lahiri & Koreman (1988) argue for Dutch that both a skeletal and a moraic level are needed to account for Dutch stress assignment. In Dutch, closed syllables count as heavy (WbP) while long vowels do not contribute to syllable weight. Therefore, stress is on the penult in words like [deːˈtɛktɔr] ‘detector’, and on the antepenultimate in [ˈmoːniːtɔr] ‘monitor’. Again, these findings are hard to explain in Moraic Theory since long vowels are inherently bimoraic and are thus expected to attract stress in weight-sensitive languages.[130]

Given these weaknesses, Tranel (1991) and Selkirk (1990) reject the assumption that geminates are inherently moraic. They argue that languages make no distinction as to whether the coda consonant is a geminate or not. In a given language, all CVC syllables are either heavy or light. This is stated in the Principle of Equal Weight for Codas (Tranel 1991), which postulates that CVC syllables are always treated the same. His view finds support in various languages such as Selkup, Malayalam, Chuvash and Tübatulabal. Tranel’s claim, however, turned out to be too strong. Davis (1999) presents a variety of languages that make a distinction between light CVC syllables closed by a singleton and heavy CVC syllables closed by a geminate.[131] His data covers a wide range of phenomena such as vowel shortening, prosodically triggered selection of allomorphs and application of umlaut.

A similar pattern is also found in German dialects. For Middle Bavarian stressed syllables, Seiler (2009: 243ff.) reports that vowel length depends on whether the following consonant is a singleton or a geminate. In open syllables, the vowel is always long (67)a). In closed syllables, the vowel is long when the following consonant is a

[130] Lahiri & Koreman (1988) assume that Dutch has contrastive vowel length. This view, however, is controversial, see Botma & van Oostendorp (2012) for discussion.

[131] See Davis (2011a) for an overview. Important work on the subject include Sherer (1994), Davis (1999, 2003, 2011a, b), Topintzi & Zimmermann (2014).

singleton (b) or a consonant cluster (c). However, when followed by a geminate, the vowel is short (d).[132]

(67) a. [leː.d̥ɒ] ‘leather’
b. [g̊rɔːb̥] ‘grave’
c. [nɔːχd̥] ‘night’
d. [ʋiʃ.ʃn̩] ‘wipe (inf.)’
[viʃʃ] ‘fish (pl.)’

Seiler (2009: 256ff.) analyses the long vowels in Bavarian monosyllables as an instance of MSL. Stressed syllables must be bimoraic. The data in (67)d) obviously meet this requirement, suggesting that the final consonant is moraic. The lengthening of the vowel in (b) and (c) indicates that Weight-by-Position does not apply in Bavarian. Final consonants thus do not contribute to syllable weight unless they are geminates. This is further proof that geminates are inherently moraic and may pattern together with heavy syllables to the exclusion of other CVC syllables.

4.2.1.2. Criticism on Moraic Theory II: the representation of initial geminates

In contrast to skeletal theories, Moraic Theory dispenses with subsyllabic constituents such as onset and rhyme. Instead, the onset–rhyme asymmetry is reflected directly by the presence or absence of moras. The implication is that moras not allowed in syllable-initial position. Word-initial geminates are therefore problematic for Moraic Theory. The fact that geminates are inherently moraic seems to exclude them from non-moraic onset positions. However, although they are rare in the world’s languages (Muller 2001; Kraehenmann 2011; Dmitrieva 2012; also: Hayes 1989), they exist, and their existence is a severe predicament for a theory that considers onsets non-moraic.[133]

The fundamental question arises as to how initial geminates should be represented if moras are precluded from the onset. A theory that prohibits moraic onsets makes the strong prediction that either initial geminates do not occur in the world’s languages or that they must be represented differently. Since initial geminates are attested, the first statement certainly is false. Hayes (1989: 302) concedes that Moraic Theory “provides

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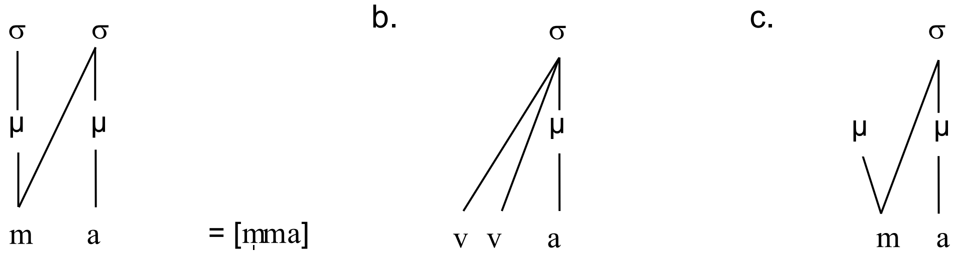
[132] The examples are taken from Seiler (2009: 244f.) based on Pfalz (1913). The notation reads as follows: singletons are rendered as devoiced *lenis* consonants, and geminates are doubled *fortis* consonants.

[133] While there is some evidence that final geminates imply the existence of medial geminates (Muller 2001), no such implication is attested for initial geminates. Among the languages that solely have initial geminates are Pattani Malay (Abramson 1986; Hajek & Goedemans 2003) and Leti (Hume et al. 1997). See Kraehenmann (2011) and Hamzah et al. (2016) for an overview.

no straightforward way to represent a syllable-initial geminate” and offers various proposals on how to represent word-initial geminates, shown in (68). One possibility is to assume that the first half of the geminate constitutes a syllable of its own (a). Alternatively, initial geminates can be represented as two segments (b), or with an extrasyllabic – i.e. stray – mora (c):

(68) a. b. c.



In (68)a), the mora constitutes a separate syllable. Hayes (1989: 302) suggests that such a representation is suitable for languages such as Luganda or Ponapean, “where the first half of a geminate … is tone-bearing”.

(68)b) corresponds to a representation of geminates as a cluster of identical segments. For Bernese, Ham (1998: 21f.) suggests distinguishing between long consonants that are geminates, i.e. weight-bearing, and “simply doubled consonants” which consist of two root nodes. He claims that Bernese initial geminates have the latter structure. It is, however, noteworthy that Ham only takes derived geminates into consideration. In particular, he bases his analysis on infinitive / past participle pairings like the ones described in 2.4.1. In ZG, however, initial geminate stops are also found in simplex words. As mentioned previously, while (b) may adequately represent fake geminates, it fails to capture geminate integrity.[134]

Leti, an Austronesian language, illustrates this (Hume et al. 1997). Leti requires that words are minimally bimoraic. Words containing an initial geminate and a short vowel fail to meet this requirement, suggesting that word-initial geminates are non-moraic. In processes such as metathesis and vowel reduction, Leti initial geminates pattern with consonant clusters. This would be in accordance with the representation in (68)b). However, Leti has optional “downgrading”, where the first lexeme in a syntactic phrase undergoes destressing. According to Hume et al. (1997: 372), downgrading is “systematically blocked if the first word contains a long vowel or geminate consonant”.

[134] One should add that such a representation is problematic as it violates the Obligatory Contour Principle (OCP, cf., Leben 1973; McCarthy 1986), that states that adjacent identical elements are prohibited. Hayes (1989: 302) proposes that OCP violations are “considerably stronger for underlying representations than for derived forms.”

This can be interpreted as an integrity effect. Hume et al. thus conclude that downgrading makes reference to multiply linked structures, as in (68)a) or (c).[135]

Lastly, (68)c) is only possible at word edges as it violates the *Strict Layer Hypothesis* (Selkirk 1984b; Nespor & Vogel 1986), which demands each prosodic category of one level to be exhaustively parsed within the next higher level of the prosodic hierarchy. This is congruent with Hayes's view that tautosyllabic geminates are restricted to word edges. Word-medially, geminates are heterosyllabic, and the mora is incorporated into the preceding syllable. Although Hayes's proposals seem rather *ad hoc,* he justifies them on typological grounds:

> [S]yllable-initial geminates … raise a general question about the evaluation of theories. In describing these configurations, moraic theory faces some awkwardness in comparison to segmental prosodic theories. Yet these configurations are demonstrably marked, being avoided in numerous languages. The compensation for the descriptive awkwardness of moraic theory is that it can be interpreted as directly reflecting the markedness of the relevant configurations. In contrast, segmental prosodic theory says nothing about why so many languages should avoid … syllable-initial geminates.
>
> Hayes (1989: 303)

The representations in (68) all act on the assumption that onsets are non-moraic. Recall that Moraic Theory in the tradition of Hayes (1989) adheres to non-moraic onsets to motivate the structural asymmetry between onsets and rhymes. We thus would not expect onsets to be involved in processes reserved for moraic elements. Recent research, however, found that there are languages where the onset contributes to syllable weight. One of them is the Austronesian language Trukese (or Chuukese). Trukese has a minimal word requirement: CV or CVC are light and therefore prohibited. Contrary to Leti, word-initial geminates contribute to syllable weight. This is shown in (69), where monosyllabic words can either have a long vowel (a) or an initial geminate (b), suggesting that the mora of the geminate contributes to the syllable weight (cf. Davis 2003: 92f.):

(69)	a.	[maː]	'behaviour'
	b.	[sːɔ]	'thwart of a canoe'

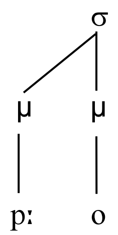
Trukese is problematic under the assumption that onset elements are never moraic. There are, however, no principled reasons to exclude onsets from being moraic.

[135] See Curtis (2003) and Kiparsky (2003) for an alternative view.

Topintzi (2008: 176) claims that geminates are moraic by definition; consequently, weightless geminates must be fake geminates. Note that her approach radically differs from that of Hayes (1989) in that she proposes to give up the “stipulation that onsets are never moraic” (p. 147).[136] She provides evidence that onsets play a role in different weight-related prosodic processes such as word minimality (Trukese, Bella Coola), stress assignment (e.g. Pirahã) and reduplication (Bellonese). In fact, onsets even trigger CL: Samothraki Greek deletes onset /r/ while lengthening the following vowel, e.g. /ˈrema/ > [ˈeːma] ‘stream’, /ˈðedru/ > [ˈðeduː] ‘tree’ (cf. Topintzi 2011: 1297).

Topintzi (2006, 2008) advocates abandoning the assumption that onsets are non-moraic. For word-initial geminates, she proposes the representation in (70).

(70)



Selkirk (1984a) relates the typological uncommonness of initial geminates to the standard view that sonority generally rises towards the syllable peak and falls thereafter. This tendency is known as the Sonority Sequencing Principle (SSP), given in (71).

(71) Sonority Sequencing Principle (SSP):[137]
The sonority profile of the syllable must rise until it peaks, and then fall.

Selkirk (1991) proposes that tautosyllabic geminates (72)a) behave like ordinary obstruent clusters (b). Since there is no rising sonority towards the nucleus, they are avoided cross-linguistically. The same holds for post-vocalic tautosyllabic consonant clusters and geminates, where sonority must decrease, cf. (73).

(72) a. *[kːat]
b. *[kpat]

(73) a. *[tapk]
b. *[takː]

---

136 By giving up the standard assumption of nonmoraic onsets, Topintzi (2006, 2008) also challenges the heterosyllabic – flopped – representation of medial geminates. Data from Marshallese and Trique suggest that word-medial geminates, too, may be syllabified in the onset. For an early account, see Mohanan (1989) on tautosyllabic word-medial geminates in Malayalam.

137 I adopt the formulation in Roca & Johnson (1999: 255). Earlier versions go back to Sievers (1901) and Jespersen (1904). For formalised accounts of sonority and syllable structure see e.g. Selkirk (1984a), Clements (1990), Vennemann (1972, 1982, 1988) and Zec (1995), and references therein.

Note that Selkirk's proposal crucially hinges on the analysis of geminates as two root-nodes. Moraic Theory is unable to account for the rarity of geminates at word edges by referring to the SSP.

As an interim summary, it can be stated that the representation of initial geminates is challenging for Moraic Theory. Representing geminates as inherently moraic, while at the same time excluding moras from onset positions, implies that word-initial geminates do not occur in the world's languages. While this may reflect a universal tendency, the model proves too restrictive for a number of languages. On the one hand, languages (e.g. Leti) have non-moraic geminates that require an adequate representation. A representation as "fake geminates" – (68)b – falls short because it fails to explain geminate integrity. On the other hand, some languages (e.g. Trukese) have prosodic processes that make crucial reference to the onset. The presence of weight-bearing onsets necessitates that they are incorporated in the model.

However, apart from the prevailing claim that onsets are universally irrelevant to higher prosodic processes, there is no principled reason to exclude moraic elements from the onset.[138] Recent work (see Topintzi 2008, 2011, and references therein) on the suprasegmental behaviour of onsets in phonological processes has shed some new light on the matter and cast doubt on the standard assumption about a general non-moraicity of onsets.

4.3. Zurich German geminates

In the previous sections of this chapter, I have outlined that geminates are traditionally considered heterosyllabic. The majority of the literature on SwG dialects are based on this premise, too.[139] In the context of Autosegmental Phonology, however, this limitation was given up, allowing geminates in all word positions.

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138 Hayes (1989) addresses the problem that the predictive power of the theory is considerably weakened when the claim of weightless onsets is given up by allowing moraic onsets. In a similar vein, Davis (1999: 100) argues that a representation where moraic onsets are generally allowed would predict that "weight sensitivity of onsets should be common" which it is not.

139 Heterosyllabicity must be separated from the concept of ambisyllabicity, which is widespread (but controversial) in German linguistics (Hall 1992; Ramers 1992; Wiese 1996; Eisenberg 2005). Ambisyllabic consonants simultaneously belong to two syllables, however, they are not considered geminates. Ambisyllabicity does not imply consonant length, rather, it is a purely phonological notion aiming at explaining phenomena where syllabification is somewhat blurred. It is closely related to the conception of syllable cut (Vennemann 1982, 1991). In German linguistics, it has been utilised to account for certain spelling rules (see Gallmann 1997 for a critical view from the Swiss perspective). ZG (along with other varieties of German) has geminates that are heterosyllabic in the appropriate contexts. On ambisyllabicity in English, see e.g. Kahn (1976), Gussenhoven (1986), Rubach (1996) and Giegerich (1992); for arguments against ambisyllabicity, see Jensen (2000).

In this section, I will argue that the *fortis/lenis* opposition is, in fact, a singleton/geminate distinction that can best be analysed in Moraic Theory.[140] I will show that geminates are underlyingly moraic. Evidence comes mainly from minimal word effects, but further prosodic processes substantiate this claim. They also support the assumption that ZG has WbP. In this context, the observations on the distribution of sonorant consonants (cf. 2.3.2.1) find further clarification. In addition, WbP is evidenced by a diachronic example of CL.

As should be clear from the above, the following is about phonological classification. Phonetic arguments are provided in Chapter 6. Foreshadowing the findings somewhat, several acoustic studies indicate that closure duration (CD) is the primary (and, according to Willi 1996, the only) phonetic correlate to the *fortis/lenis* distinction.

Heusler (1888: 30f.) discusses the existence of geminates in Basle German at some length. Although he recognises the connection between *fortis* and length, which he considers the "essential" factor for the *fortis/lenis* contrast (cf. fn. 105), he draws a clear distinction between *fortis* and geminates, stating that the latter must be heterosyllabic while "*fortis* consonants belong to a single syllable, no matter how long they may be". As an argument against geminates, Heusler (1888: 30f.) notes that Basle German *fortes* do not have two peaks ["zwei Expirationsstösse"] (cf. fn. 108). On the other hand, he also observes that short vowels that precede a geminate cannot be stretched ["unter keinen Umständen dehnbar"]. In his view, this is due to the influence of the following *fortis* consonant, which leads him to suggest that the *fortes* "also belong to the first syllable". He concludes that "after short vowels, we have to state geminates". Winteler confirms these findings in a personal letter to Heusler:

> Es lässt sich nur negativer Weise die Bestimmung aufstellen, dass gegenwärtig in der angegebnen Stellung die Fortis niemals blosser Anlaut der folgenden Silbe ist.[141]
>
> Heusler (1888: 32, quoting from Winteler's letter)

Heusler further states that geminates may also occur after long vowels and vowel + sonorant clusters. Quoting from Winteler's letter, Heusler (1888: 34) notes that

[140] Technically speaking, 'singleton' and 'geminate' suggest a skeletal representation where the contrast is modelled by one vs two units. For convenience, I will stick to this terminology. Note that it is purely heuristic. As laid out in 4.2.1, geminates are inherently moraic consonants and singletons are not.

[141] Transl. KW: "It can only be stated in a negative way that at present in the position given [i.e. word-medially after a short vowel], the fortis is never the mere onset of the following syllable."

Winteler, too, recognises the possibility "'that after a long vowel, a diphthong and sometimes also after a liquid' the beginning of *fortis* falls into the first syllable."[142]

Weber (1948) identifies word-medial obstruent geminates after both, short and long vowels:

> Während die Schriftsprache nur geschriebene Doppelkonsonanten … kennt, gibt es in den meisten schweizerdeutschen Mundarten wirklich gesprochene konsonantische Doppellaute (Geminaten) […] Im Zürichdeutschen ist der Doppelcharakter nicht so stark ausgeprägt wie in den meisten benachbarten Mundarten … Dies gilt besonders für die Stellung nach langem Vokal.[143]
>
> Weber (1948: 36)

In accordance with the traditional view, Weber attributes the primary distinction between the two voiceless series to intensity. His use of 'geminate' is restricted to *fortis* consonants in heterosyllabic position. He does not assume a three-way contrast; rather, he considers gemination a concomitant that naturally accompanies *fortis* consonants word-medially. This is, in essence, the position of Winteler and Heusler.

Haas (1978: 311ff.) also broaches the issue of the relation between *fortes* and geminates, decidedly stressing that there is no three-way contrast. As mentioned previously, he assumes a long/short opposition, where the actual length of a [+ long] consonant is context-dependent. Thus, geminates are the phonetic variant of underlyingly [+ long] consonants that occur in intersonorant position. In principle, this corresponds to the view expressed in this thesis: we are dealing with a two-way contrast in which the *fortis* has two allophones.[144]

It is mainly for two reasons that analyses in terms of a singleton/geminate contrast came relatively late. First, Winteler cast a long shadow over Swiss German dialectology, and many researchers still adhere to his insights and terminology. Second, the assumption of a singleton/geminate contrast requires that tautosyllabic geminates be allowed. However, given that the *fortis/lenis* contrast in ZG is not

142 Note that Winteler must have abandoned his previous view. In his 1876 publication of the *Kerenzen Vernacular,* Winteler (1876: 143) argues that *fortis* consonants after long vowels, diphthong or liquid, are entirely syllabified in the onset of the following syllable: "ganz zur neuen Silbe gehört sie nach langem Vokal, Diphthong oder Liquida."

143 Transl. KW: "While Standard German knows double consonants only in writing, most of the Swiss German dialects have indeed spoken double sounds (geminates). In Zurich German, the doubling character is not as pronounced as in most neighbouring dialects, especially after a long vowel."

144 Cf. Chapter 5. In a somewhat hidden form, we find such an analysis in Spaelti (1994), too. A 3-way contrast, where *lenis, fortis* and geminates are analysed as distinctive sounds was proposed in Ham (1998) on Bernese. See Ehrenhofer (2013: 31ff.), Kraehenmann (2003), and Würth (2002: Chapter 4) for a critical review.

accompanied by either voicing or aspiration, and that duration is the only clear correlate for the distinction, a singleton/geminate opposition seems an obvious solution.

4.3.1. Monosyllabic lengthening (MSL) and word minimality

It has already been laid out in 2.4.5 that ZG lengthens the vowel in monosyllabic content words of the structure CVC where the final consonant is a *lenis* consonant ("Leichtschlussdehnung", Bohnenberger 1953). (74) shows that the underlying representation (UR) of these words has a short vowel that is preserved in disyllabic words. If the word is monosyllabic, the vowel is long.

(74)	UR	singular	plural	diminutive	
a.	/hɒs/	[hɒːs]	[hɒsə]	[hæsli]	'rabbit'
b.	/ʃlɒk/	[ʃlɒːk]	[ʃlɛːk]	[ʃlekli]	'stroke'
c.	/huːs/	[huːs]	[hyːsər]	[hyːsli]	'house

The pattern in (74) is thus suspiciously reminiscent of Hawaiian, cf. (63). In the following, I will argue that ZG, too, has minimal word restrictions requiring that the minimal word is bimoraic. If this condition is not met, lengthening occurs.[145]

Minimal word restrictions are frequent in the world's languages. Many languages disallow content words that consist of a single light syllable. Thus, MSL is a repair strategy designed to augment subminimal words to the required size (e.g. McCarthy & Prince 1986; Hayes 1995; Hall 1999; van de Weijer 2002). Since only monosyllabic words can be subminimal, MSL often leads to vowel length alternations between monosyllabic and disyllabic words in a paradigm.[146] The singular forms in (74) are monosyllabic and have a long vowel. Diminutive formation takes the suffix *-li,* thereby making the word disyllabic. In (a), the plural is formed by adding an affix containing a vowel, which again makes the word disyllabic. In both cases, the vowel remains short. If plural formation is achieved solely by umlaut (b), the vowel is long. This clearly indicates that MSL is purely phonological, i.e. that there is no morphological shortening rule. In (c), the vowel in the disyllabic forms is long, suggesting a long vowel in the

[145] Seiler (2009) shows that German dialects avail themselves of several lengthening strategies, vowel lengthening being only one of them. In the dialect of Valais (Highest Alemannic), the bimoraicity constraint is achieved by gemination of the final – underlyingly non-moraic – consonant.

[146] See e.g. Winteler (1876) on the vernaculars of Toggenburg and Kerenzen, Heusler (1888) on Basle German, Stucki (1921) and Keller (1961) on ZG and Bernese, Bohnenberger (1953) on Alemannic in general, Auer (1989) on the dialect of Constance. A useful overview on a variety of alternation phenomena in SwG dialects is Chapman (1995). Comprehensive studies of the development of quantity systems in German dialects are provided in Naiditsch (1997), Page (2001, 2007), Seiler (2009) and Goblirsch (2018).

underlying representation. Whenever we find alternation, however, the underlying vowel is short, and the long vowel in the monosyllables is the result of MSL.[147]

Since word minimality crucially refers to syllable weight, it is a diagnostic to determine which elements are weight-contributing in ZG. Consider the following examples (from Seiler & Würth 2014: 144f.):

(75) a. [seː] 'lake'
b. [ʃɒtə] 'damage'
c. *[ma] (but [mɒː]) 'man'
d. *[hɒs] (but [hɒːs]) 'rabbit'
e. [hɒsː] 'hatred'
f. [hunt] 'dog'

(75) shows that ZG permits monosyllabic words of the structure CVV (a) as well as light syllables (b). Content words of the structure CV (c) or CVC (d) are not allowed. Crucially, words ending in a geminate (e) or in a cluster (f) are well-formed. Under the assumption that geminates are inherently moraic, the well-formedness of (e) is straightforward: both, the vowel and the consonant contribute a mora and thus fulfil the minimality requirement. CVC words closed by a non-moraic consonant, on the other hand, pattern with CV words. In order to meet the minimality condition, an additional mora is required. As a consequence, vowel lengthening occurs.[148]

Although the final consonant in (d) does not appear to contribute to the syllable weight (hence the word is subject to MSL), I assume that ZG has WbP. Evidence comes from words that end in a cluster. As (f) shows, they are not lengthened. The long vowel in (d), on the other hand, is due to segment extrametricality. Word-final obstruents are extrametrical. In the representations in (76), extrametricality is indicated by angled brackets. Extrametrical consonants are invisible to prosodic processes, and WbP fails to apply.

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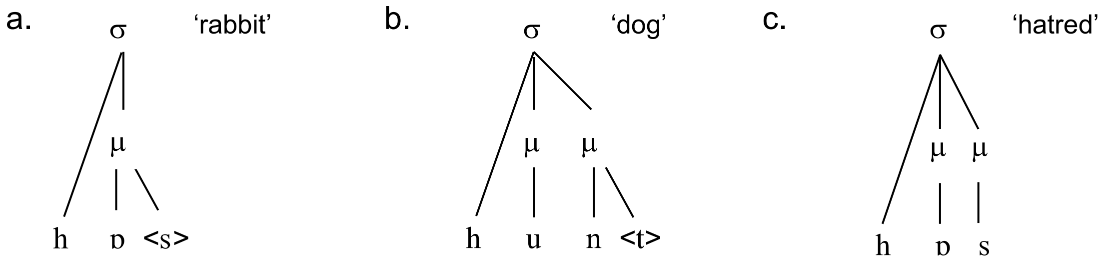
147 Similar analyses for SwG dialects have been put forward by Spaelti (1994) for the Kerenzen vernacular and Kraehenmann (2003) for Thurgovian. See Seiler (2005b) for an analysis of Bernese, which shortens underlyingly long vowels in disyllabic forms.

148 Since ZG permits stressed light syllables, long vowels in monosyllables cannot be attributed to the levelling of previously lengthened open syllables. This is the standard explanation for a similar phenomenon in StG (e.g. Paul 1884; Lahiri & Dresher 1999); but see Naiditsch & Kusmenko (1992), Kusmenko (1995), Naiditsch (1997), Page (2001, 2007) for a different view. They argue that MSL is a process prior to Open Syllable Lengthening (OSL). Seiler (2009) considers OSL and MSL two independent processes.

(76)



In (76)a) the final obstruent is extrametrical. Therefore, the word is monomoraic and must be lengthened. In contrast, (b) and (c) are bimoraic, and no lengthening takes place. Crucially, the mora in (b) is a *structural* mora that is assigned by WbP. The mora in (c), on the other hand, is inherent. Note that final consonant extrametricality only affects singletons. This is an instantiation of Ham's (1998: 20) hypothesis that languages with word-final geminates and WbP always have extrametrical singletons:

> [I]n a language which shows evidence that CVC syllables are heavy and permits geminates to appear word-finally … assignment of weight by position to word-final singletons should fail.
>
> Ham (1998: 20f.)

Under the assumption that word-final geminates have the representation in (76)c), they cannot be distinguished on the surface from singletons that are moraic by position. Final consonant extrametricality thus is a means to ensure the distinction between word-final geminates and singletons.[149]

In ZG, final CVC syllables pattern with medial CV syllables, and final CVCC patterns with medial CVC. I assume that the extrametrical consonant is adjoined to the preceding mora.[150] ZG syllabifies across word-boundaries, leading to resyllabification at phrase-level. Crucially, however, the long vowel remains (cf. also (92), below).[151]

An open question is whether MSL is still active in Swiss German dialects. This is the position advocated here. Several recent studies share this view (e.g. Spaelti 1994; Würth 2002; Seiler 2009; Seiler & Würth 2014). In contrast, Heusler (1888: 16ff.) assumes that MSL has ceased to be active in SwG dialects. He bases his claim on the presence of certain monosyllabic words of the structure CVC. In particular, he mentions the imperative singular, where the vowel systematically fails to lengthen, (77). Heusler

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149 Note that for sonorants, this distinction is unnecessary as long as they do not have a singleton/geminate contrast or as long as their categorial status can be retrieved otherwise.

150 Kraehenmann (2003: 32) assumes that at phrase boundary extrametrical consonants are adjoined to the phonological word.

151 In compounds, the vowel is short, e.g. [pɒt + hosə] 'swimming trunks (lit. bath trousers)', [huf + isə] 'horseshoe (lit. hoof iron)'. See Chapman (1995) and Weber (1948: 71) for further examples.

(1888: 20) assumes that “the combination of short vowel and lenis that was originally only legitimate word-medially was analogically transferred to the coda”.[152]

(77) [lis] ‘read (imp.sg.)’
[kip] ‘give (imp.sg.)’
[ʃʊik] ‘be silent (imp.sg.)’

Stucki (1921: 28) offers a slightly different line of reasoning. He argues that the paradigmatic alternation between monosyllabic and disyllabic forms is still present, provided that both forms are sufficiently frequent. However, if one of the two forms dominates, the alternation is eliminated in favour of the more common expression. Consequently, levelling could proceed in both directions. On the one hand, long vowels (from MSL) could be extended to disyllabic contexts when the disyllabic word is rare. Unfortunately, Stucki does not provide any examples. Perhaps he refers to forms ending in a sonorant consonant, such as e.g. ʃʊɒːn ‘swan’, ʃɒːm ‘shame’, ʃpiːl ‘game’. In fact, nouns ending in a sonorant consonant often have no plural ending (e.g. ʃʊæːn ‘swans’) or no plural at all (e.g. ʃɒːm), which makes such an analysis plausible. On the other hand, short vowels were reintroduced in cases where the disyllabic form is predominant. According to Stucki, this is what happened with verbs and adjectives. Because disyllabic verb forms are more common than monosyllabic verb forms, levelling took place in favour of the short vowel. As for the adjectives, it should be noted, however, that Stucki’s considerations rely entirely on a single adjective, namely *grob* [krop] ‘coarse’.[153]

The assumption that the short vowels in monosyllabic verb forms are the result of paradigmatic levelling is rather implausible. It implies that they once were subject to MSL and that lengthening was reversed at a later stage. However, if these words were never affected by MSL, their subminimal form can hardly be accounted for by analogy. Rather, they do not participate in MSL for principled reasons. I assume that verbs do not undergo MSL. Note that the forms are not as infrequent as Stucki seems to believe. In ZG, not only the imperative and subjunctive forms have a short vowel but also the

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152 “[D]ie ursprünglich nur im Inlaut berechtigte Verbindung kurzer Voc. + Lenis [wurde] auch in den Auslaut übertragen.”

153 Apart from *grob,* which is to my knowledge the only adjective that does not meet the minimal word requirement, there are a handful of nouns which also evade the restriction: *Snob, Smog, Grog, Chog* ‘snob, smog, rascal, bugger’. The first three are obviously English loans and their pronunciation may be due to the effort of the speakers to speak flawless English. The fact that alveolar fricative + nasal cluster do not occur in the native vocabulary, additionally qualifies *Snob* and *Smog* as foreign. It is noteworthy, however, that two of my informants pronounced *Snob* as [snopː]. One of them had a long vowel in [kroːp]. This clearly shows how deeply anchored the minimality condition is within ZG phonology.

singular forms of the infinitives *sy* 'be', *haa* 'have', *chöne* 'can', and *möge* 'may'. The paradigms in (78) illustrate this:[154]

(78)

	sy 'be'	haa 'have'	chöne 'can'	möge 'may, like'
inf.	[siː]	[hɒː]	[xønə]	[møkə]
1. sg.	[pi]	[hɒ]	[xɒ]	[mɒk]
2. sg.	[piʃ]	[hæʃ]	[xɒʃ]	[mɒkʃ]
3. sg.	[iʃ]	[hætː]	[xɒ]	[mɒk]

Note that the augmentation fails to apply only if the word ends in a singleton *obstruent*. We already know from 2.3.2.1, that tautosyllabic sonorants are lengthened if they follow a short vowel:

(79) a. [fərˈt͡selː] 'tell (imp.sg.)' b. [fərˈt͡selə] 'tell (inf.)'
[holː] 'fetch (imp.sg.)' [holə] 'fetch (inf.)'

Two aspects are of importance here. First, unlike nouns, verbs escape the requirement of word minimality. Second, only word-final obstruents are extrametrical. If a monosyllabic verb form ends in an obstruent, it remains monomoraic, e.g. [kip] 'give (imp.sg.)', because the final obstruent is extrametrical. As for word-final sonorant consonants, no extrametricality applies and the sonorant is lengthened by means of WbP. Recall Ham's assumption that the task of extrametricality is to avoid WbP in word-final singletons in order to distinguish them from geminates. Since singletons and geminates occur in complementary distribution, there is no need to mark them as extrametrical.[155]

It has long been recognised that minimality conditions are typically restricted to content words (e.g. McCarthy & Prince 1993; Prince & Smolensky 1993; Kenstowicz 1994; Hayes 1995; Kager 1999). Hall (1999: 102) argues that "function words are 'exceptional' because they are not p[rosodic] words." Several authors point to the close relationship between content words and stress. Culminativity requires words to be stressable. Thus, many languages impose a "stressability requirement" (Kager 2007: 196) on phonological words. This requirement typically equals a foot (i.e., two moras).

[154] Cf. Weber (1948: 180ff., 186f.). The forms in the shaded cells are irrelevant to the point made here and are given only for the sake of completeness. Note that the subminimal form occurs irrespective of whether it is used as a full verb or as an auxiliary or modal.

[155] See Keller (1961: 45) for a similar explanation. On the newly developed behaviour of adjectives, which has led to a minimal phonemic load in word-medial position, cf. 2.3.2.1.

Grammatical words, on the other hand, are typically exempt from culminativity. Consequently, repair strategies invoked in order to achieve minimum word size do not apply. Moreover, there are differences between the lexical categories. Smith (2011: 2442f.) reports that verbs are less often subject to augmentation than nouns.[156] These observations also hold for ZG, where function words consisting of a single light syllable are numerous. However, alternations between short and long vowels are also attested for function words, cf. (80).

(80) a. [sæp ˈmæitːli] 'that girl' b. [ti ˈsæːp] 'that one'
[t͡su ˈmiːr] 'to me' [uf mi ˈt͡suə̯] 'towards me'
[fo ˈtɛnə] 'of these' [təˈfoː] 'thereof'
[us əm huːs] 'out of the house' [forˈuːs] 'ahead (lit. for-out)'

The alternations in (80) all show the same pattern: function words are light (a) unless they are stressed (b). Weber (1948: 203) and Stucki (1921: 36) provide ample data, which illustrate this alternation. As can be gleaned from (81) below, no lengthening occurs when the word is disyllabic (a) or ends in a geminate consonant (b).

(81) a. [ti ˌsæpə ˈmæitːli] 'those girls' b. [ti ˈsæpə] 'those ones'
[mitː ˈirə] 'with her' [ˌnimː si ˈmitː] 'take her with (you)'

An additional type of alternation comes from particle verbs, as shown in (82). ZG particle verbs are combinations of a particle or a preposition and a verb stem. In the infinitive (a), they look like ordinary prefixes.[157] In the main clause, however, the particles are separated from the stem (b) and the final consonant surfaces as a geminate. Presumably, this is a further instance of word minimality. Augmentation becomes necessary as soon as the particle is in a position where it must constitute a phonological word of its own. In this case, however, bimoraicity is not achieved by vowel lengthening but by the gemination of the final consonant.[158]

(82) a. [ˈɒpˌʋæʃːə] 'to do the dishes (lit. up-wash)'
[ˈʋɛkˌrænə] 'to run away (lit. away-run)'
[ˈʋɛkˌluə̯kə] 'to look away (lit. away-look)'
b. [ər ʋæʃt ɒpː] 'he does the dishes (lit. he washes up)'
[si rænt ʋɛkː] 'she runs away'
[ər luə̯kt ʋɛkː] 'he looks away'

---

156 Note that Spaelti (1994: 7) calls MSL in the Kerenzen vernacular "monomoraic *noun* lengthening" (emphasis added).

157 Particle verbs exist in all German varieties including StG. In the infinitive, they are spelt without a space in Standard German orthography: *abwaschen – er wäscht ab, wegrennen – sie rennt weg.*

158 This seems to contradict Keller's (1961: 47) claim that vowel lengthening is the preferred strategy if gemination leads to a categorical change. I have no explanation for this.

Considering such ample alternation data, it is doubtful that these alternations are all allomorphs, stored in the lexicon. I follow Hayes (2009: 230) in assuming that the presence of alternations is indicative of a still ongoing process. Especially the lengthening of function words in stressed positions shows that MSL is still active in ZG phonology.

4.3.2. Additional evidence for moraic consonants in Zurich German

In the previous section, I have argued that words ending in a *fortis* consonant do not undergo MSL because they are inherently moraic. In this section, I will present additional evidence indicative of the weight-bearing nature of ZG segments. They come from three different areas: stress placement, lengthening triggered by the diminutive affix and compensatory lengthening. They all have in common that the processes are quantity-related.

First, syllable weight and stress placement are closely interconnected, as languages tend to stress heavy syllables (Hayes 1995). Although little is known about ZG stress, I will outline some basic observations and argue that they are best explained in terms of moraicity.[159]

ZG stress assignment is quantity-sensitive. However, many words have initial stress, even if the first syllable is light and followed by a heavy syllable. In words that consist of three or more syllables, penults must be heavy to obtain primary stress. This can easily be demonstrated by the fact that when reading written words, speakers are sometimes uncertain whether stress is on the penult or on the antepenult. A somewhat famous example is the word *Banago,* the brand name of an instant chocolate powder, which could in principle be stressed either on the initial syllable or on the penult. Crucially, when stress falls on the latter, the syllable is invariably heavy. Thus, speakers either pronounce it [ˈpɒnɒko] or [pɒˈnɒːko], while [pɒˈnɒko] is illicit.[160] Similarly, final syllables can only get primary stress when they are heavy. Words such

[159] To my knowledge, ZG stress has not been systematically studied so far. In the following, I refer to my own (unpublished) research, which has in part been presented in Würth (2004a) and Würth (2004b). I will come back to ZG word stress and its relevance for Moraic Theory in 5.2.4.2.

[160] A third option, which would also be grammatical, is the lengthening of the consonant: [pɒˈnɒkːo]. Since the letter <g> does not represent the geminate, speakers do not make use of this possibility. However, penults containing a geminate may receive main stress, as [moˈnɒkːo] 'Monaco' demonstrates.

as [pɒˈletː] ‘ballet’, [k͡xoˈlosː] ‘colossus’ and [k͡xrɒˈʊɒlː] ‘riot’ all have ultimate stress, supporting the claim that the final consonants are moraic.

Second, we find some idiosyncratic patterns of vowel lengthening. Contrary to primary stress outlined above, secondary stress assignment is regular. Stress is assigned to heavy syllables and to the leftmost syllable in a foot of two light syllables (i.e., on the basis of moraic trochees). If moraic consonants contribute to syllable weight, closed syllables should always receive stress. In ZG, words ending in a full vowel lengthen the vowel when the diminutive suffix *-li* is attached, (83).[161]

(83)		[ˈk͡xino]	→	[ˈk͡xiˌnøːli]	‘cinema’
		[ˈiklu]	→	[ˈiˌklyːli]	‘igloo’
		[ˈæu̯tːo]	→	[ˈæu̯tˌtøːli]	‘car’

The examples indicate that the syllable preceding the diminutive suffix must be heavy. As a result, vowel lengthening only affects light syllables. The examples in (84) suggest that the prediction is borne out. Not surprisingly, no changes occur when the vowel is long (a). However, lengthening also fails to apply when the syllable is closed by a geminate (b) or a cluster (c). The former is again evidence for an analysis of *fortis* consonants as geminates. The latter is further proof that ZG has WbP.

(84)	a.	[ˈkɒˌrɒːʃ]	→	[ˈkɒˌræːʃli]	‘garage’
		[ˈpɒlˌsɒːm]	→	[ˈpɒlˌsæːmli]	‘balm’
		[ˈk͡xɒnɒpˌpeː]	→	[ˈk͡xɒnɒpˌpeːli]	‘sofa’
		[ˈmonitˌtoːr]	→	[ˈmonitˌtøːrli]	‘monitor’
	b.	[ˈmɒˌmutː]	→	[ˈmɒˌmytːli]	‘mammoth’
		[ˈkiˌrɒfː]	→	[ˈkiˌræfːli]	‘giraffe’
		[ˈtːrotːiˌnetː]	→	[ˈtːrotːiˌnetːli]	‘scooter’
	c.	[ˈk͡xoˌpolt]	→	[ˈk͡xoˌpøltli]	‘goblin’
		[ˈʃimpˌpɒns]	→	[ˈʃimpˌpænsli]	‘chimpanzee’

Third, a compelling argument in favour of Moraic Theory is Compensatory Lengthening (Hayes 1989). A diachronic process of ZG that relates to CL is the *Staubsche Gesetz* ‘Staub’s Law’ (Staub 1874; Werlen 1977). Named after its discoverer, Friedrich Staub, it is well-known in Swiss dialectology. It states that in nasal + fricative sequences, the nasal deletes and the preceding vowel is lengthened. The process is no longer active

161 The data are partly from Würth (2004b). Umlaut regularly accompanies diminutive formation in ZG and can be neglected here. Some of the examples probably seem a little far out, however, Swiss German dialects are notorious for making extensive use of diminutive forms. Diminutive does not merely convey a smaller degree of its root meaning, but is also used to express affection, cf. Weber (1948: 327ff.)

in ZG; however, its reflexes are still visible. The examples in (85) are from Weber (1948: 58f.):[162]

(85)	hɒŋf	> ZG	[hæu̯fː]	'hemp'
	t͡siŋs	> ZG	[t͡sei̯s]	'interest, rent'
	fænʃtər	> ZG	[fæi̯ʃtər]	'window'
	fynf	> ZG	[føi̯f]	'five'
	[uns]	> ZG	[øi̯s]	'us'

The examples above show that the deletion of the nasal did not affect the mora. Staub's Law is thus further evidence for the existence of WbP in ZG.

In this chapter, I have so far argued for an analysis of the ZG *fortis* consonants as geminates. I have presented several quantity-related processes which showed that *fortis* consonants contribute to syllable weight, while *lenes* do not. Substantial evidence is from minimal word conditions and stress placement, where syllables closed by a geminate count as heavy. Lengthening of function words and separated verbal particles under stress are further evidence that word minimality is still active.

Analysing the above patterns in Moraic Theory makes the correct predictions: geminates are associated with a lexical mora, whereas singletons are non-moraic. Singleton consonants, however, may receive a structural mora via WbP. Several processes point to the presence of WbP in ZG. First, monosyllabic words that end in a cluster are not affected by MSL. I have argued that final singleton obstruents are extrametrical. Thus, WbP does not apply to words of the structure CVC. Staub's Law is further evidence that ZG has WbP. Vowel lengthening occurs as a means of mora preservation after the deletion of the nasal. This implies that the coda sonorant must have been moraic. Examples from stress assignment and diminutive affixation also confirm the general pattern that geminates contribute to syllable weight, and singletons do not, unless they are structurally linked to a mora.

4.3.3. Onset geminates?

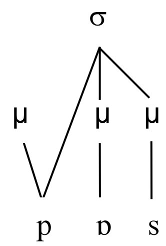
ZG has word-initial geminate stops (2.3.1). Perception tests (Kraehenmann 2003) revealed that the contrast can only be perceived in phrase-medial contexts. When

[162] The diphthongisation has taken place after the nasal deletion and subsequent CL (cf. Werlen 1977). In an earlier stage, the vowel was long. Is still reflected in a number of neighbouring dialects, e.g. [yːs] 'us', [t͡siːs] 'interest, rent', cf. SDS II, maps 124 and 127, respectively.

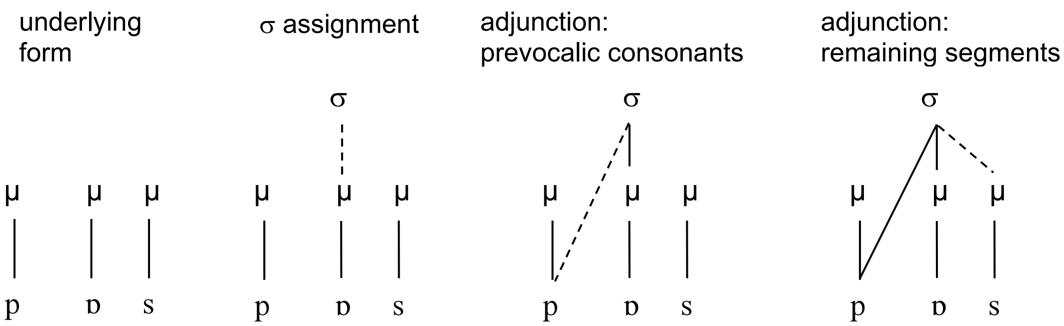
preceded by a vowel or a sonorant consonant, geminate stops clearly differ from their singleton counterpart, as shown in (86):[163]

(86) a) /tə pɒsː/ → [təpɒsː] 'the bass'
/æu̯ pɛːrli/ → [æu̯pɛːrli] 'also bears (dim.)'
b) /tə pːɒsː/ → [təpːɒsː] 'the passport'
/æu̯ pːɛːrli/ → [æu̯pːɛːrli] 'also pairs (dim.)'

Section 4.2.1.2 has shown that Moraic Theory struggles with word-initial geminates. If one abandons the too strong hypothesis that onsets are moraless, however, moraic onsets can be integrated into the theory. I will largely adopt the structure proposed in Hayes (1989) and Davis (1999) and assume that ZG onsets are indeed associated with a mora. I suggest that the structure in (68)c) – repeated here as (87) – is a direct effect of the syllabification algorithm shown in (88).

(87)


'passport'

(88)


The algorithm in (88) shows that the mora of word-initial geminates cannot be incorporated into the onset in ZG. Therefore, word-initial geminates do not contribute to syllable weight. If the onset were weight-contributing, we would expect the vowel in (89) to remain short. Instead, Monosyllabic Lengthening occurs:[164]

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[163] Ehrenhofer (2013: 30) points out that "if factors other than CD played a role in perception, it would be possible to recover the distinction initially." However, the contrast is inaudible, as perception tests by Kraehenmann (2003) for Thurgovian strongly suggest. Fulop's (1994) measurements on initial geminates indicate higher formants when the vowel is preceded by a *fortis* stop than when it follows a lenis stop (see also 6.1 for some critical remarks).

[164] It has been pointed out that in certain languages onsets are weight-contributing (cf. e.g. Davis 1999, 2017; Topintzi 2006, 2008; Topintzi &Davis 2017; Topintzi & Zimmermann 2014). I assume that it is determined on a language-specific basis whether or not word-initial geminates contribute to syllable weight. Certain languages – such as ZG – exhibit initial geminates, which, however, have no influence on quantity-related processes.

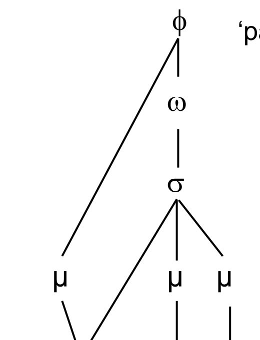
(89)

	singular	plural	diminutive	
/tːɒk/	[tːɒːk]	[tːæːk]	[tːækli]	‘day’

Evidence for the structure in (87) comes from three different sources. First, it is corroborated by the fact that Swiss speakers clearly sense a difference when articulating isolated /pɒsː/ and /pːɒsː/, even phrase-initially, where it is impossible for the hearer to determine the starting point of the closure. In a study using electropalatography, Kraehenmann & Lahiri (2008) measured the degree of linguopalatal contact and demonstrated that speakers have longer oral closure for initial geminates than for their singleton counterparts. This means that the contrast is articulated, although it is not perceived by the listener. The speakers’ ability to distinguish singletons from geminates should, therefore, be reflected in different representations.

For phrase-initial geminates, Kraehenmann (2003: 35) proposes the licensing of an additional X position which is directly associated with the phonological word. However, such a structure is not possible in Moraic Theory because the licensed mora would make the phonological word bimoraic, which would falsely predict the prevention of MSL, cf. (89). Instead, I assume that the mora is directly adjoined to the phonological phrase, cf. (90).[165]

(90)



‘passport’

Second, moras manifest themselves phonetically in the duration of the closure, which cannot be calculated by the listener at the beginning of the phrase. Phrase-medially, however, the mora can be interpreted when it flops to the coda of a preceding syllable. Onset geminates are thus possible; however, they do not contribute to syllable weight.

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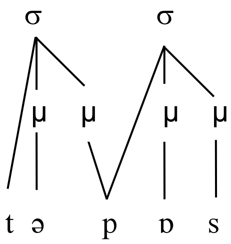
165 See, however, Kiparsky (2003), who takes a different view on comparable data in Arabic dialects.

The representation in (87) has all the ingredients required to account for the paradoxical behaviour of word-initial geminates in ZG: on the one hand, they are longer in intersonorant environment, and SwG speakers are aware of the fact that they are categorically distinct from singletons. On the other hand, word-initial geminates do not contribute to syllable weight. This is because the mora is not embedded in the onset of the syllable. Quantity-related processes, such as MSL or stress assignment, refer to lower domains. They are therefore blind to the moraicity of word-initial geminates. In intersonorant contexts, geminates are long and exhibit the familiar flopped structure.[166]

(91)



'the passport'

Third, historically, SwG dialects underwent schwa apocope in several contexts. As shown in 2.4.1, the prefix for past participle formation is [kː], which developed from MHG *ge-.* The outcome of the process as a geminate can again be interpreted as an instance of mora conservation: the mora which was formerly linked to schwa did not disappear when schwa was deleted, but instead reassociated with the adjacent consonant. As a result, the consonantal prefix is moraic.[167]

The adjunction of the word-initial mora to a preceding word is postlexical, not only because it occurs across a word boundary, but also because it does not prevent the application of MSL. Also, lengthening is not reversed. Once MSL has been applied, the vowel remains long, cf. (92):

(92)	[mɒː] 'man'	[mɒnə] 'men'	[tə mɒː tːræfːə] '(to) meet the man'	*[tə mɒ tːræfːə]
	[hɒːs] 'rabbit'	[hɒsə] 'rabbits'	[ən hɒːs tːøːtə] '(to) kill a rabbit'	*[ən hɒs tːøːtə]

[166] See Topintzi & Zimmermann (2014) for a somewhat similar analysis of Thurgovian within Containment Theory (Prince & Smolensky 1993). They (2014: 81) propose that the initial geminates are "not phonetically dominated by a μ but since the underlying μ always remains in the structure in containment, the geminate remains structurally different from a singleton onset: it is doubly linked to a syllable (even though one of the association paths is phonetically invisible). And this double linking is then interpreted as length."

[167] I assume that the gemination of the velar stop is an instantiation of compensatory lengthening. This proposal has already been made by Page (2001: 237). On other analyses, see fn. 65. There are other morphemes where schwa apocope had the same effect. The prefix *be-,* as e.g. in StG *behalten, behüten* 'keep, protect (inf.)', is apocopated in some ZG verbs: [pːhɒltːə], [pːhy̯ətːə]. Furthermore, compare the definite article [tː] (cf. 2.4.1) with its allomorph [ti], and the clitic [tː] 'you (2.sg.)' with the unreduced form [tuː].

4.4. Zurich German syllable structure and syllabification

Studies on the syllable structure of ZG are still outstanding. Syllables and syllabification are sometimes mentioned in passing when referring to stress or sandhi phenomena (e.g. Moulton 1986; Fleischer & Schmid 2006; Reese 2007). The only principled analysis I am aware of is Kraehenmann (1996, 2003) on the related Alemannic dialect of Thurgovian. I will discuss her analysis, which is also instrumental for her account on neutralisation, in 5.2.3.

In the present thesis, I adopt the syllabification algorithm proposed in Hayes (1989: 257ff.) I will further specify it by suggestions made by Hall (1992). Fig. 10 below gives a schematic overview. I will comment on the individual steps in turn.

Syllabification is governed by two primary principles: the Maximal Onset Principle (93), which essentially states that onset formation precedes coda formation, and the Sonority Sequencing Principle (cf. (71) – repeated here as (94) –, which captures phonotactic constraints in terms of sonority.[168]

(93) *Maximal Onset Principle* (henceforth: MOP)[169]
Intervocalic consonants are maximally assigned to the onsets of syllables in compliance with universal and language-specific requirements.

(94) *Sonority Sequencing Principle* (henceforth: SSP):[170]
The sonority profile of the syllable must rise until it peaks, and then fall.

The SSP states that the nucleus is the sonority peak, and sonority always increases towards the nucleus and decreases afterwards. I follow Kraehenmann's (2003: 11) proposal that all obstruents are of equal sonority. The sonority scale is shown in (95).

(95) Obstruents < nasals < liquids < glides < vowels

---

[168] Vennemann (1972: 11) additionally proposes the Law of Initials (LOI), which requires that "[m]edial syllable-initial clusters should be possible word-initial clusters". Vennemann (1988: 32) later reformulated it as "[w]ord-medial syllable heads [i.e. onsets] are the more preferred, the less they differ from possible word-initial syllable heads of the language system."

[169] See Kahn (1976), Selkirk (1982), Steriade (1982). Clements & Keyser (1983) refer to it as the "Onset First Principle", Itô (1986) calls it the "CV-Precedence Principle". In optimality-theoretic approaches, it is captured by ONSET (Prince & Smolensky 1993).

[170] See Selkirk (1984a), Clements (1990), Blevins (1995), here in the formulation of Roca & Johnson (1999: 255). On the sonority scale, cf. e.g. Vennemann (1982: 284) and (1988: 9).

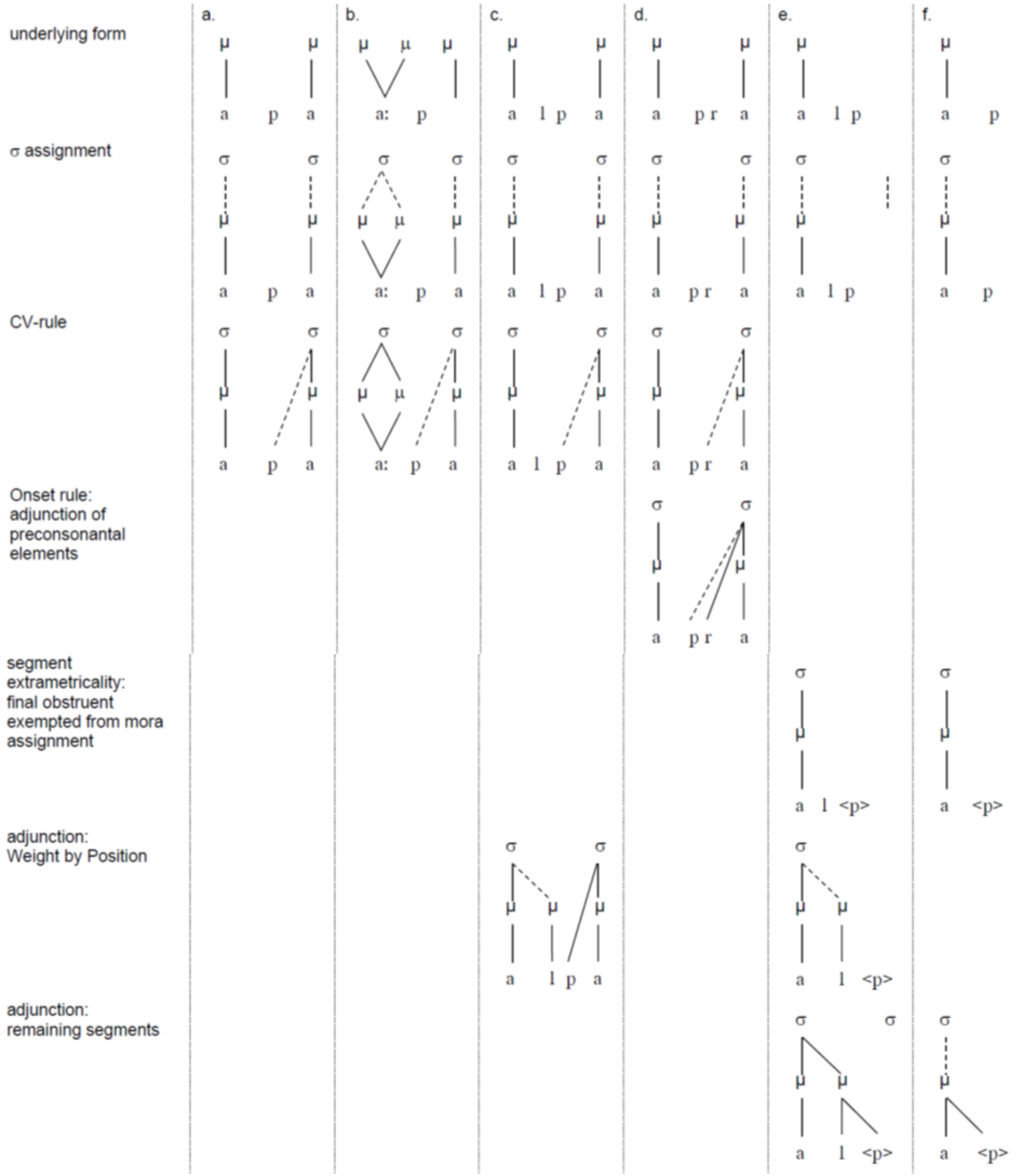


Fig. 10: Syllabification algorithm for ZG

As a first step in the algorithm, syllables are established by “selection of certain sonorous moraic segments … for domination by a syllable node” (Hayes 1989: 257). More specifically, syllable nodes are “in a one-to-one correspondence with [+ syllabic] sounds.”[171] Conversely, the second step, the CV-rule, only affects [+ cons]

[171] See Hayes (2009: 253). The exact formulation of the σ-assignment rule depends on the specification of vowels in the root node. Hall (1992: 59f.), who couches his analysis in X-Theory, proposes that the nucleus only contains segments specified for [- cons]. I assume a root node specification [- consonantal, + sonorant] for vowels, but nothing hinges on this decision and the same result is predicted.

segments.[172] Hayes (1989) remains rather unspecific about complex onsets, probably assuming that they apply in an iterative fashion. In Hayes (2009: 253), he refers to the Maximal Onset Principle (MOP). He seems to have in mind Vennemann's (1972, 1982) Law of Initials when he states that consonants are joined to the following syllable, "provided the resulting cluster can occur at the beginning of a word". To account for the difference between the universal CV-rule and the adjunction of further consonants in the onset, I adopt Hall's (1992: 60) proposal of an additional *Onset Rule,* which allows preconsonantal segments to form a complex onset.

The CV rule, as well as the onset rule, make sure that onset formation precedes coda formation. This is captured by the Maximal Onset Principle (93). Thus, in a VCV string, the word-medial consonant is always syllabified in the onset. A VCCV string, on the other hand, is syllabified in conformity with the SSP. Thus, while hypothetical /apra/ is syllabified as [a.pra] in a language that allows complex onsets (as ZG), /alpa/ is syllabified as [al.pa], because the sonorant is more sonorous than the following stop and therefore, only the stop can be part of the onset.[173]

In the next step – and thus departing from Hayes's syllabification algorithm – I include a final segment extrametricality rule that prevents word-final singleton obstruents from being seen by higher prosodic structure. Extrametricality phenomena are widely acknowledged (Hayes 1995; see Hyde 2011 for an overview). Due to the Peripherality Condition (Hayes 1982, 1995; Harris 1983), extrametrical elements are only allowed at the edge of a domain. As soon as an element is no longer at the edge of a domain, it loses its extrametrical marking.

The extrametricality rule only applies to word-final non-moraic (i.e. singleton) segments. It is ordered before the Weight-by-Position rule; in fact, the very purpose of the rule is to exclude word-final singletons from mora assignment (cf. Ham 1989: 20f.; Hayes 1995: 58). As a consequence, WbP only applies to non-final consonants or, put differently, to the left-most member in a post-vocalic consonant cluster. Motivation for this assumption comes from MSL, presented in 4.3.1 above.

172 The term is coined by Steriade (1982) to account for the universal tendency that languages syllabify VCV as V.CV in order to have an onset.

173 Word-medial sonorant clusters are always separated by a syllable boundary. Thus, /amra/ is syllabified [am.ra], regardless of the fact that the sonority rises. Onset adjunction probably only applies to obstruents.

Lastly, the remaining segments are adjoined to the syllable. It is questionable whether they are assigned under the mora node or directly under the syllable node. I assume that they are dominated by the preceding mora, thus submitting to the Strict Layer Hypothesis (Selkirk 1984b). Note, however, that postvocalic segment adjunction applies very late in the derivation. In fact, it can be seen as a “last resort” mechanism that only comes into effect when it is impossible to assign the segments to the following onset.

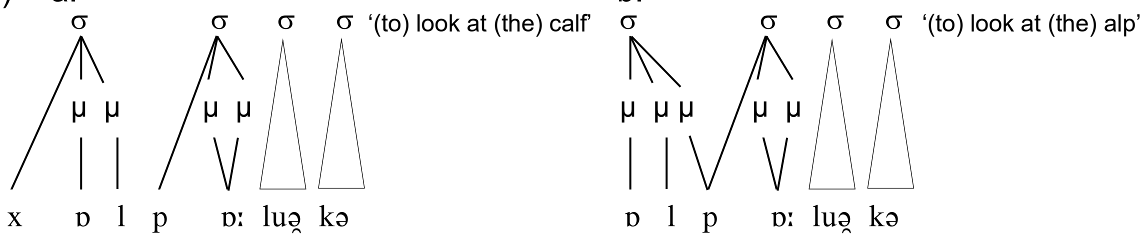
The algorithm in Fig. 10 applies to word-internal syllabification as well as syllabification across word boundaries. In the following, we will look at phrasal contexts more closely. It has long been noted that Swiss German dialects do not employ strategies to mark morphological boundaries. Contrary to closely related varieties as e.g. the standard language, ZG has no *Wortgrenzsignale*. Standard German, on the other hand, clearly signals word (and morpheme) margins: final devoicing, vocalisation of final rhotics and glottal stop insertion before vowel-initial words all serve the purpose of identifying the word margins in a syntactic context. ZG lacks such strategies. This is a clear indication that ZG syllabification does not align with the morphological structure and (postlexical) resyllabification applies.

According to Moulton (1986: 385), SwG dialects only exhibit “textual boundaries”, i.e. pauses in the speech flow. Kraehenmann (2003: 12f.), essentially echoing Moulton, considers the phonological phrase “the domain of syllabification in Swiss German”.

In this context, the question arises as to how resyllabification works and, more specifically, how extrametrical consonants are integrated into the phrase. In principle, the same conditions hold as in Fig. 10. I assume that resyllabification applies across the board, given the requirements imposed by the SSP are met. Thus, obstruents resyllabify in the following onset, even if the resulting cluster does not – or only rarely, as e.g. /km/ or /sl/ – occur word-initially.

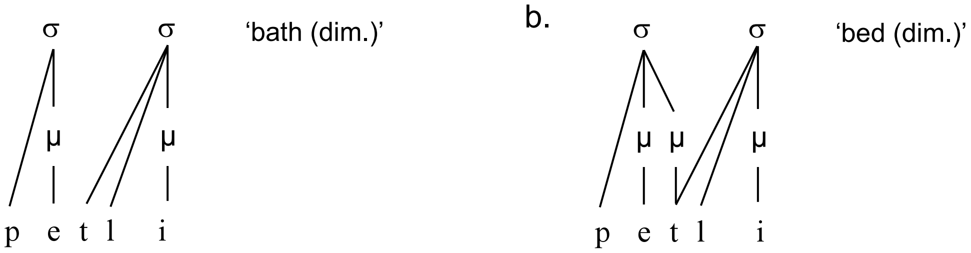
Two aspects are crucial here. First, extrametrical obstruents are incorporated into the following syllable. This is due to the Peripherality Condition, which states that extrametrical elements are only permitted at the edge of a domain. Since in ZG, the domain of the syllabification is the phrase, extrametricality is revoked (96)a). Secondly, final geminates again have the familiar flopping structure (b).

(96) a. b.



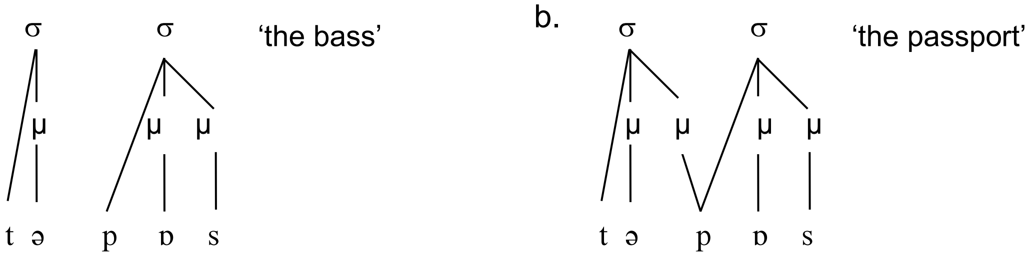
Singletons and geminates can be distinguished not only intervocalically but in every intersonorant context. I assume that resyllabification is enforced by the SSP. The SSP applies even if the resulting onset is not a possible word-intial cluster, thereby violating the Law of Initials. ZG words, for instance, never begin with /tl/ (as in many languages), whereas such clusters do occur after resyllabification.

(97) a. b.



Moras of word-initial geminates are not syllabified in the onset, see (98)b). If preceded by a sonorant sound, the mora is integrated into the previous syllable.

(98) a. b.



A distinction must be made between lexical and postlexical syllabification. /hɒs/ and /mɒ/ in (99) are both subject to MSL. If syllabification applied only once – at a postlexical level –, we would expect that lengthening fails to appear whenever resyllabification is possible (a), or when the following consonant is moraic (b). In both cases, however, the vowel is long. MSL is a lexical process that cannot be reversed postlexically.

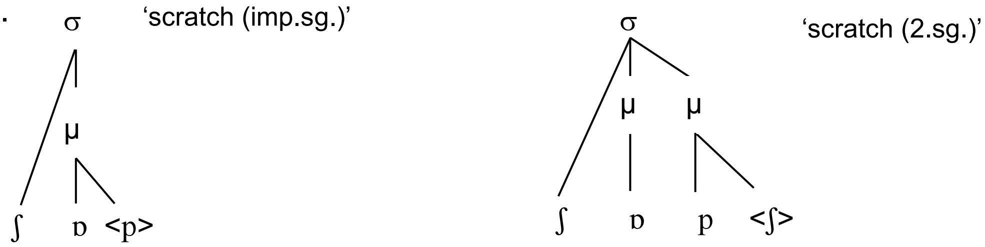
(99) a. /t͡sum/ /hɒs/ /ɒnə/ [t͡sum.hɒː.sɒ.nə] *[t͡sum.hɒ.sɒ.nə]
'towards the rabbit'

b. /tə/ /mɒ/ /tːræfːə/ [tə.mɒːt.træf.fə] *[tə.mɒt.træf.fə]
'(to) meet the man (acc.)'

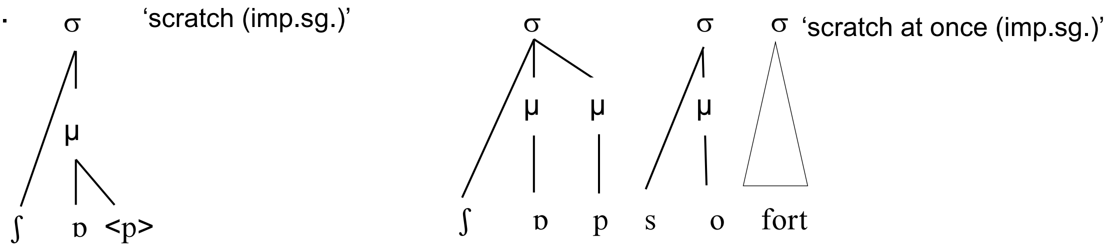
(99) indicates that the domain for minimality is the phonological word.[174] This is in line with earlier proposals (e.g. Nespor & Vogel 1982; Nespor 2007) that all languages have syllabification at the word level while resyllabification at a later point in the derivation is language-specific. It is difficult to determine at which higher prosodic domain resyllabification takes place, however, as there seem to be no limits for postlexical sandhi processes, I concur with Moulton (1986) that resyllabification applies in the domain of the phonological phrase.

By contrast, WbP applies lexically and postlexicallly. As depicted in (100), word-final consonants that are otherwise extrametrical may be subject to WbP. Since the Peripherality Condition requires extrametrical consonants to be at the margin of the domain, the extrametrical marking is lost when a morpheme is attached (a) or in phrasal contexts (b):

(100) a.



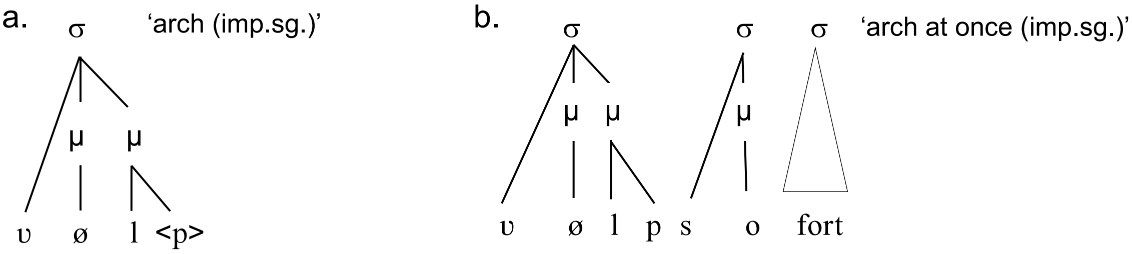
b.



Since no extrametrical positions are licensed within the phonological phrase, all consonants must “squeeze” into the syllable. In particular, if the following word begins with an obstruent, no resyllabification is possible. I assume that stray material adjoins the preceding mora.

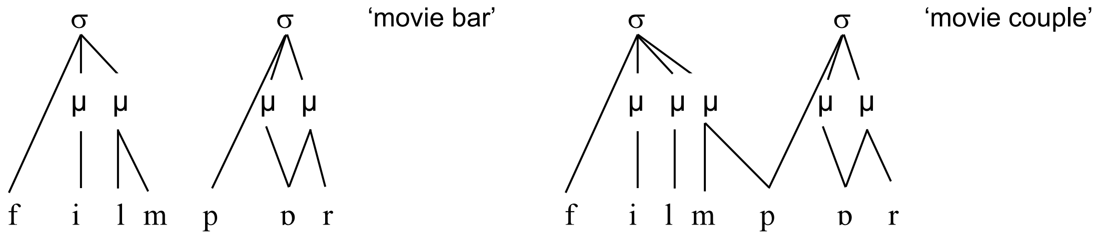
174 Lengthening also occurs regularly when the word in question is the second member of a compound, e.g. /[t͡sɒl/+/tːɒk/ → [t͡sɒltːɒːk] ‘pay-day’, /pɒːn/+/hof/ → [pɒːnhoːf] ‘railway station’. When it is the first member, however, the vowel sometimes remains short. Compare e.g. /tːɒk/+/loː/ → [tːɒːkloː] ‘day labour’ (Weber 1948: 71) with /tːɒk/+/ɒk͡xtːiːf/ → [tːɒːkɒk͡xtːiːf] ‘diurnal (animal)’. Similarly, we find unsystematic patterns with derivational suffixes: /høf/+/li/ → [høfli] ‘courteous’ vs /klas/+/ik/ → [klaːsik] ‘glassy’ (Weber 1961: 116, 87). See also Chapman (1995) for further examples.

(101) a. b.



An unresolved question is how to integrate the mora of word-initial geminates into a preceding syllable that already occupies three positions as in (102). Kraehenmann (2003: 36) predicts neutralisation; however, she does not provide evidence in support of her claim. Since, in my perception, a contrast is audible, I assume that it can be integrated into the preceding syllable.[175]

(102)



4.5. Summary

This chapter has demonstrated that ZG has geminates. Evidence comes from various processes that show that ZG distinguishes between heavy and light syllables. Geminates always make a syllable heavy. In Moraic Theory, this falls out naturally from the modelling of geminates as moraic. Quantity-related phenomena, therefore, find a straightforward explanation.

Additionally, I have shown how syllabification proceeds in ZG. Before I move on to discuss neutralisation in the next chapter, let us recapitulate the findings so far:

– ZG has a singleton/geminate contrast in the obstruent system.
– Geminates are realised heterosyllabically in suitable (i.e. intersonorant) phrase-medial contexts.
– ZG nouns and adjectives are minimally bimoraic; if a word does not fulfil this condition, the vowel is lengthened (MSL).
– Coda consonants are assigned a structural mora by Weight-by-Position; word-final obstruents are extrametrical, and thus excluded from WbP.

[175] In my data material, such instances occur, see fn. 203.

- ZG syllabification follows the Sonority Sequencing Principle (SSP); it does, however, not conform to the Law of Initials.
- ZG operates on a lexical and on a postlexical level.
- MSL is a lexical process. Once lengthened, the vowel irreversibly remains long.
- Weight-by-Position applies lexically and postlexically.
- Extrametricality applies only at the edge of the phonological phrase. Due to the Peripherality Condition, only domain-final elements can be extrametrical. The domain of syllabification in ZG is the phonological phrase. Phrase-medially, word-final obstruent extrametricality is therefore revoked, and the obstruents are subject to WbP.

5. Neutralisation

By definition, phonemes contrast with each other and phonemic differences lead to semantic differences. In certain contexts, however, the underlying contrast is suspended, or, "neutralised". The concept of neutralisation goes back to the Prague School and is laid out most clearly by Trubetzkoy (1989 [1939]). It will be addressed momentarily.

This chapter falls into two major parts. The first part reviews some key concepts of neutralisation. It will turn out that the approaches presented in the first part almost exclusively relate to segmental features. The second part discusses neutralisation of suprasegmental contrasts. One of the most important contributions is Kraehenmann (2003), whose study on Thurgovian is used as a reference point for the remainder of the chapter. Her analysis is couched in X-Theory and will be discussed at some length. In 5.2.3, I will lay out the implications of Kraehenmann's approach and then proceed to account for neutralisation in Moraic Theory in 5.2.4. It will turn out that a skeletal analysis of neutralisation leads to entirely different predictions than an analysis in Moraic Theory. 5.2.5 summarises the chapter and gives an outlook on the questions that are at the heart of the phonetic investigation.

5.1. Key concepts of neutralisation

This section gives an overview of basic concepts of neutralisation and briefly discusses some current theoretical approaches. I will start with an example that will help illustrate the different concepts at issue.

Since neutralisation is context-dependent, it often leads to paradigmatic alternations.[176] A textbook example is final devoicing in StG. In (103), the voiced obstruent is voiceless in syllable-final position (a), while the contrast is maintained word-medially (b). Thus, while /d/ and /t/ contrast – cf. (b) vs (d) –, the voicing opposition is suspended in (a). Voiced stops never occur in this position; thus, the contrast between underlyingly voiced (a) and voiceless (c) sounds is neutralised.

[176] On the differentiation between dynamic and static neutralisation, see e.g. Hayes (2009: 133f.).

(103) a. /baːd/ → [baːt] ‘bath’
b. /baːdən/ → [baːdən] ‘bathe (inf.)’
c. /baːt/ → [baːt] ‘begged (3.sg.pst.)’.[177]
d. /baːtən/ → [baːtən] ‘begged (1./3.pl.pst.)’.

Such observations have formed the basis for a broad theoretical discussion that led to various analyses. They are outlined in more detail below. As a starting point, I choose Trubetzkoy’s subdivision into four different types of neutralisation. This seemingly unorthodox excursion into the history of phonological theory is expedient since Trubetzkoy’s typology takes us further than what is reflected in most subsequent work. Later work and theorising focused almost exclusively on one specific type of neutralisation, notably the collapse of a distinction into one of the feature values.

In the remainder of this section, I present a selection of prevalent approaches. In 5.1.2, I will discuss two constraint-based proposals on neutralisation, the syllable-based approach “licensing-by-position” (Itô 1986, 1989) and the cue-based approach “licensing-by-cue” (Steriade 1997, 1999). Sections on incomplete neutralisation (5.1.3) and on the function of neutralisation (5.1.3) complete the first part.

5.1.1. Trubetzkoy and the archiphoneme

In his pioneering work *Grundzüge der Phonologie* (1939), Trubetzkoy observed distributional asymmetries among phonemes. He found that contrary to plain allophony, where the two exponents of a phoneme are in complementary distribution and therefore never contrast, there are particular positions where the distinctive power of otherwise contrasting phonemes is suspended.[178]

Trubetzkoy (1989: 61) makes a preliminary distinction between bilateral and multilateral oppositions [“eindimensionale und mehrdimensionale Gegensätze”]. The former describes the opposition of two members. In (103), [voice] is bilateral since the

177 For clarity, a terminological note is in order. Oftentimes, the term *allophony* is used exclusively in contexts where the variants of a particular phoneme are distinct from exponents of another phoneme. Under this view, the distribution of Standard German [x] and [ç] is regarded as allophonic whereas StG final devoicing is an instance of neutralisation. Clearly, the two concepts are to be kept distinct although they overlap. Allophony describes the various shapes a phoneme takes and the conditions which govern the distribution. From this perspective, [t] and [d] are allophones of the phoneme /d/ in StG. Neutralisation, on the other hand, refers to the loss of contrast in a particular context leading to identical phonetic realisations of two otherwise distinct phonemes. In StG, obstruents are voiceless in syllable-final position. Thus, the allophone [t] happens to coincide with a sound that exists independently in the phoneme inventory.

178 It should be mentioned that Trubetzkoy makes a distinction between contrast and opposition. The former refers to the distinction between phonemes, whereas the latter refers to distinctions within the structure of a phoneme (i.e. its organisation in terms of features).

basis of comparison occurs in only two phonemes, /p/ vs /b/. If a property is shared by more than two phonemes, the opposition is multilateral. In English, the relationship between /p/, /t/ and /k/ is multilateral, as they are all distinguished along the dimension of oral stops.

Trubetzkoy (1989: 71) claims that neutralisation is only possible for bilateral oppositions where the archiphoneme is understood as "the sum of the distinctive properties that are common to two phonemes."[179] This view, however, turned out to be inadequate. In particular, it falls short of explaining many instances of place assimilation (cf. Lass 1998: 46ff.). Place assimilation of nasal consonants in Zurich German may serve as an example. (104) shows that ZG distinguishes nasals according to their place of articulation (a). When followed by an obstruent consonant, however, we only find homorganic nasal-obstruent clusters (b). Clearly, the nasal is neutralised in that position.

(104) a. ʃtrɒm 'tight'
ʃtrɒŋ 'thread'
mɒxt 'power'
nɒxt 'night'
b. pːlompə 'filling'
ʋæntə 'turn around'
k͡xoŋko 'Congo'

In the classic example of devoicing, (103) above, the alveolar stops differ only with respect to the absence or presence of the feature [voice]. For bilateral oppositions, Trubetzkoy introduces the concept of the "archiphoneme" which appears when two phonemes fail to contrast. According to Trubetzkoy (1989: 71), the archiphoneme consists of all the features two phonemes have in common, except for the feature that distinguishes them. Thus, the voice opposition lost in (103)a) does not result in the phoneme /t/, but in an archiphoneme /T/ (traditionally indicated by a capital letter) that does not possess the contrastive status /t/ does. Archiphonemes, which by definition occur in positions of neutralisation, are thus "segments of dilemma, neither distinctively x or non-x" (Donegan & Stampe 1979: 162).

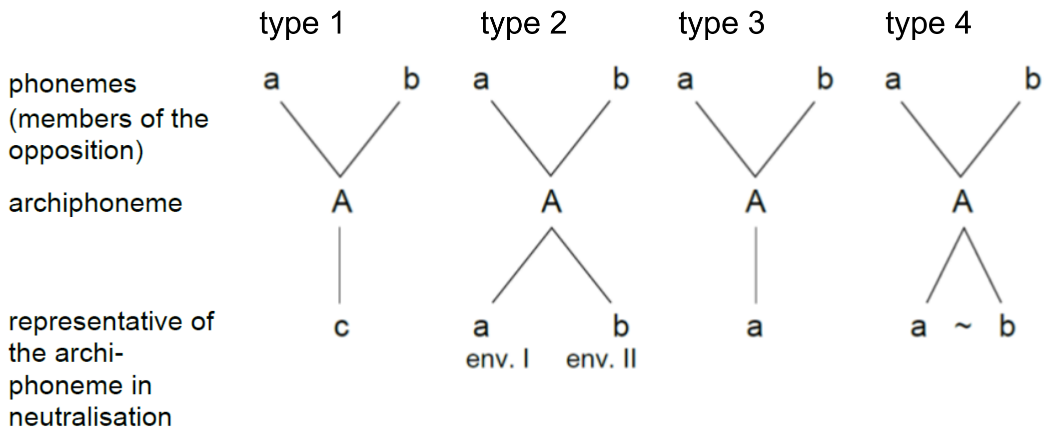
The concrete manifestation of the archiphoneme at the phonetic surface is the representative of the archiphoneme. For final devoicing in Standard German, the

[179] Orig.: "wobei wir unter Achiphonem die Gesamtheit der distinktiven Eigenschaften verstehen, die zwei Phonemen gemeinsam sind."

representative is the voiceless variant. Thus, the representative of the archiphoneme is identical to one of the normally contrasting members. Cases where the segment in positions of neutralisation corresponds to one of the two opposing phonemes are frequent and have received the most attention in phonological theory. The main idea is that the segment that appears in neutralisation contexts carries the unmarked feature value of the contrast.

Trubetzkoy's typology, however, goes beyond such cases. He (1989: 71ff.) lists four possibilities of how the representative of the archiphoneme can be realised. A schematic overview is given in (105).[180]

(105)



In type 1, the representative of the archiphoneme that occurs in a position of neutralisation is distinct from both of the opposition members. An often-cited example is tapping in most varieties of North American English. The examples in (106) show that the tap [ɾ] occurs as an allophone of /d/ and /t/ between two vowels when the second vowel is unstressed:[181]

(106) a. ladder [ˈlæɾɚ]
madder [ˈmæɾɚ]
b. latter [ˈlæɾɚ]
matter [ˈmæɾɚ]

---

180 I follow the representation from Lass (1998: 50).

181 Although the contrast between /t/ and /d/ is suspended intervocalically, many words can yet be distinguished. Dinnsen (1985: 269) reports "that for those American dialects examined, the vowel before those flaps derived from underlying /d/ are approximately 10% longer than the vowel before flaps derived from underlying /t/ […] The underlying distinction between /t/ and /d/ is thus preserved in the phonetic representation of vowel duration before flaps." Lass (1998: 31) discusses in detail the difference between *writer* and *rider*. The diphthong that precedes the voiced stop is generally longer than the one which precedes the voiceless stop, leading to the allophones [ɑˑɪ] vs [ɑɪ]. When the alveolar stops collapse into an alveolar tap, the preceding environment leaves a trace of the underlying structure. Thus, a formerly predictable allophonic distribution becomes the only cue for distinguishing the two words. The phonemic contrast of the stops – /rɑɪdər/ vs /rɑɪtər/ – has moved to the previous diphthong, rendering a phonetic contrast [rɑˑɪɾɚ] vs [rɑɪɾɚ]. Similar observations are at the core of incomplete neutralisation, cf. 5.1.3.

Crucially, the archiphoneme is represented by neither of the members that occur in the contrasting environment. According to Trubetzkoy (1989: 71f.), there are two possibilities: either the archiphoneme is realised by a sound which is "phonetically related to both members of the opposition" or the representative archiphoneme is not in-between but exhibits "traits of its own". Tapping in American English can be considered an instance of the latter subtype.

In type 2, the representative of the archiphoneme is identical to one of the contrasting phonemes. The choice is determined by the context ("externally conditioned" in Trubetzkoy's terms, p. 72). Depending on the featural content of a neighbouring segment, the archiphoneme may be represented by one of the opposing members in environment A, and by the other in environment B. An example is regressive voicing assimilation in Dutch, (107). If two stops occur consecutively at a morpheme boundary, the first stop takes the voice value of the second:[182]

(107) za/kd/oek → za[gd]oek 'handkerchief'
sto/pd/as → sto[bd]as 'tie'
slo/bk/ous → slo[pk]ous 'gaiter'
wi/tb/oek → wi[db]oek 'white book'
hui/dp/looi → hui[tp]looi 'skin crease'

The archiphoneme thus has two representatives: it is either voiced or voiceless depending on the presence or absence of voicing of the following segment.

Type 3 represents what Trubetzkoy (1989: 73) calls "internal conditioning" (as opposed to "external conditioning", discussed above). Contrary to type 2, the context does not influence the choice of the archiphoneme. Only one of the opposing members is permitted in a position of neutralisation, namely the member that lacks a feature specification altogether, the unmarked ["merkmallos"] member.

This holds for privative features. Trubetzkoy (1989: 73) adds a variant where the opposition is not privative but gradual. For gradual oppositions, Trubetzkoy (1989: 73) assumes that the archiphoneme that occurs in the neutralisable opposition ["Aufhebungsstellung"] is represented by the "external" or "extreme" member of the opposition. As examples, he mentions different degrees of aperture in vowels, or between the different levels of tone. This makes the strong prediction that in gradual

182 The data is from Trommelen & Zonneveld (1979, cit. in Kager 1999: 90).

oppositions, "intermediate" phonemes would never make a representative of the archiphoneme.[183]

Finally, the archiphoneme can be represented by both opposition members. Type 4 differs from external conditioning (type 2) in that the choice of the representative cannot be attributed solely to the phonetic make-up of the context. The choice is driven by multiple factors, be they external or internal. Trubetzkoy (1939: 74) conjectures that this case is a combination of type 2 and type 3. Lass (1998: 50) provides an example from Danish where the opposition between aspirated and devoiced stops is suspended in final position. In the position of neutralisation, both members may occur. Thus, Danish *lap* 'patch' is pronounced either [lapʰ] or [lab̥], apparently interchangeably.

If we accept Trubetzkoy's typology, we are to determine which type Heusler's Law belongs to.[184] The majority of descriptions point out the in-between nature of the neutralised obstruent and tellingly label it "half-fortis". This suggests that the archiphoneme is of a third kind (i.e. type 1), thus non-identical with either of the opposing members. Phonetic measurements corroborate this impression (cf. Chapter 6). Classification as type 1, however, raises a couple of questions. First, under the assumption that phonological features are implemented into the phonetic component directly, the emergence of allophones that are not identical with either of the two opposing members is clearly unexpected.[185] As mentioned previously, the majority of the phonological literature has focused on cases where the segment in positions of neutralisation is identical with one of the two opposing phonemes, the general

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183 Vowel height probably should be viewed as a multilateral opposition. Since Trubetzkoy presumed that neutralisation only occurs in bilateral oppositions, an explanation in terms of multilateral oppositions was not viable. Vowel height can be handled in binary terms. In the SPE, a hypothetical vowel system of three vowel heights would be broken down into binary features. Thus, the "extreme" poles are specified as [+high] and [+low], respectively, and the intermediate position is assigned a minus value for both. A non-binary approach seems also possible with reference to "rate features" as proposed by Ladefoged (1971), cf. Lass (1998: 107ff.). I will come back to the specification of gradual features in 5.2.1 below.

184 Ignoring the peculiar development of adjectives described in 2.3.2, the different lengths resulting from Winteler's Law can be understood as allophonic variation. Note that allophony is not part of the neutralisation types in (105), since in Trubetzkoy's conception neutralisation requires the presence of two phonemes. However, the development of the allophonic system outlined in 2.3.2.1 may be accounted for by type 2: depending on the quantity of the preceding vowel, only one of the two opposing phonemes (singleton and geminate sonorant) was allowed.

185 In fact, Kiparsky (1976: 169) rules out type 1 as a neutralisation type. He formulates the following general conditions for neutralisation: A rule of the form A → B / XC_DY is neutralising *iff* there are strings of the form CBD in the input to the rule. Other rules, i.e. structure-building rules, are non-neutralising. This rule obviously is more restrictive than Trubetzkoy's (and others') conception of neutralisation. As it disallows any addition of new structure, instances of type 1 in Trubetzkoy's taxonomy are not regarded as neutralisation. Kiparsky's claims are closely related to the notion of structure preservation (Kiparsky 1985). Contrast reduction is structure-preserving when the allophonic variant coincides with a sound that is already part of the phonemic inventory. This is the case in (103), where the structure of the neutralised [t] is already present in the lexicon. In structure-building processes, on the other hand, structure is added, which has not been previously present. Such processes are prohibited in lexical derivation (see, however, Paradis & LaCharité 2011 for a critical review).

assumption being that non-neutralised values are more marked than neutralised values. The asymmetric behaviour of distinctive features in neutralisation thus is a key diagnostic to determine which feature is marked. Later studies made abundant use of these asymmetries, providing in-depth insight into the theory of markedness and underspecification (cf. e.g. Chomsky & Halle 1968; Cairns 1969; Archangeli 1988; Steriade 1995; de Lacy 2006; Rice 2007). The downside, however, is that Trubetzkoy's type 1 has virtually sunk into oblivion.[186]

Second, work on neutralisation is chiefly concerned with segmental phenomena. This is probably again strongly intertwined with the prevalent view that neutralisation serves as a diagnostic for markedness distinctions and feature hierarchies. I will address neutralisation of suprasegmental contrasts in 5.2.

5.1.2. Constraint-based approaches

Phonemic contrast, formulated in terms of distinctive features, is often restricted to certain positions which remain remarkably constant cross-linguistically. Jun (2011: 1101) calls them "non-prominent" positions. Conversely, "prominent" positions remain unaffected by phonological processes. Moreover, elements in prominent positions often trigger these processes. Constraint-based approaches capture these asymmetries by the notion of licensing. A prominent position licenses a contrast while it is not licensed in non-prominent positions. A constraint acts as a filter, which demands (positive constraint) or prohibits (negative constraint) a specific structure.[187] Non-prominent positions are thus preferred sites for neutralisation.

Two approaches prevail that aim to account for the asymmetries between neutralisation sites and loci that preserve full contrast. In the prosody-based approach (Itô 1986, 1989), neutralisation sites are defined with reference to prosodic domains, notably the syllable. In the case of final devoicing, the neutralisation site is the coda.

[186] A cursory look into student's textbooks on phonology supports this intuition. One of the standard examples for neutralisation is final devoicing. The selection is consequential since many of these introductions move on to discuss theories of markedness.

[187] This essentially corresponds to the constraints in Optimality Theory (OT), where negative constraints are starred and positive constraints are not (e.g. *CODA which prohibits codas consonants vs ONSET, stating that an output form must have a syllable onset). OT differs from earlier models in two respects. First, the constraints evaluate surface forms, and second, they can be violated without necessarily rendering an output ungrammatical. Constraints are ranked in a language-specific order and output forms are evaluated according to the "seriousness" of the constraint violations. Thus, violations of lower-ranked constraints are licit. OT originated from earlier approaches to generative phonology, and accordingly, the markedness constraints refer to concepts developed therein. Technically, any constraint-based theory can be implemented in OT. Steriade (1997) adapts the model by replacing the markedness constraints with "perceptibility conditions".

The phonology specifies the structural conditions for neutralisation (e.g. by a constraint marking voiced codas illicit). The cue-based approach (Steriade 1997, 1999), on the other hand, claims that neutralisation is syllable-independent; rather, the prominence of a position depends on “relative perceptibility” (Steriade 1999: 208).

It has been noted by many that in a VC_1C_2V environment, C_1 is more likely to undergo phonological processes (i.e. assimilation, neutralisation, deletion) while C_2 remains largely unaffected. Obviously, syllable-based approaches make crucial reference to the syllable, attributing asymmetric patterns to syllable well-formedness conditions. C_1 is more prone to phonological processes because of its position within the syllable. In other words, the coda is a non-prominent position and therefore a susceptible target for contrast reduction. The cue-based approach, on the other hand, does not refer to prosodic structure to account for the non-prominence of C_1. Steriade (1999: 205) defines it as an entirely linear approach with “string-based conditions reflecting positional differences in the perceptibility of contrasts”. Since preconsonantal C_1 has low perceptibility, the implication is that phonological contrasts are likely to neutralise in positions where an articulatory effort is needed to enhance the perceptual distinctiveness. The dismissal of the syllable makes several predictions, of which I will consider only one: in a syllable-based approach, word-final consonants and word-medial C_1 followed by C_2 are both in the coda and are thus expected to pattern alike. In a cue-based approach, however, they may behave differently. Jun (2011: 1112) provides a variety of data that corroborate that assumption. However, while dominance effects seem to be an appropriate explanation for some cases, there is also evidence in favour of the prosody-based approach.[188]

The fact that Heusler’s Law affects C_1 and C_2 alike is problematic for any approach that expects prominence differences between the two consonants in a C_1C_2 sequence. If we consider fortition (or lengthening) an increase in prominence, neutralised *lenis* obstruents in C_1 are more prominent than predicted. In addition, C_2 is affected by neutralisation, too. Cue-based licensing could, however, help understand why neutralised C_2 (again especially when *lenis*) is relatively prominent. Adjacent obstruents are invariably neutralised, irrespective of the underlying form (cf.

[188] Cf. Jun (2011) for further discussion and ample examples.

Fleischer & Schmid 2006). It should be kept in mind, however, that Heusler's Law does not involve contrastive features that can be licensed.

Winteler's Law, on the other hand, makes apparent reference to the syllable. Since word-final and coda sonorants pattern alike, a syllable-based approach seems appropriate.

5.1.3. Incomplete neutralisation

The basic assumptions about the relation between phonetics and phonology have remained virtually unchallenged over the past decades.[189] They can be summarised as a theory that conceptualises speech sounds – phones – as discrete units perceivable by humans. Importantly, each phone is a particular combination of phonetic features. The phonetic inventory of an individual language is a proper subset of the closed set of universal phonetic features. Phonetic features are considered the mental units that specify how the articulatory production and auditory perception are to be implemented. There is thus only one way to interpret (and produce) a phone, depending on the presence or absence of a feature. Consequently, speech sounds have to be either distinct or identical. The option that they are "something in between" is ruled out by the binarity requirement.

Under this condition, the phonetic outcome of neutralised sounds is straightforward: a feature value may be present – as the voicing in [baːdən] 'bathe' –, or absent as in [baːt] 'bath'. In the latter case, final devoicing results in homophony with [baːt] 'begged' where the final obstruent is underlyingly voiceless.[190]

In the past few decades, however, a series of experimental phonetic studies have produced evidence that the contrasts are often only partly neutralised. In particular, there is a large body of literature on incomplete neutralisation of voicing contrasts (cf. e.g. Dinnsen 1985; Kleber 2011; Winter & Röttger 2011; and ample references therein). The studies found that an underlying contrast led to differences in the

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189 Interestingly, it appears that current introductions to phonology hardly ever address this aspect. While student textbooks regularly devote a chapter to phonetics, they do not discuss the relationship between phonology and phonetics. If the issue is broached at all, it is dealt with briefly. The reader routinely encounters statements such as phonology is "more abstract" and that it is concerned with patterns and unconscious rules that are stored in our minds. The vagueness in the textbooks probably reflects the fact that the matter is still unresolved and broadly discussed (see Kingston 2007 for an overview).

190 I will not pursue the question of whether [voice] is a privative feature, here, as it does not affect the line of argument. In an SPE-inspired model of the phonology-phonetics interface, feature identity and distinction follow directly from the presence or absence of that feature, or that feature value, respectively.

neutralisation position. In many cases, however, the difference is not realised on the neutralised sound itself. In Standard German, the vowels before neutralised voiced stops are longer than before voiceless stops. This is reminiscent of the lengthening effects in the case of tapping (see fn. 181). Researchers also reported differences in aspiration, duration and closure duration.

There are different views on how incomplete neutralisation has to be interpreted, going from radical standpoints that claim that there is no such thing as true (or complete) neutralisation (Port & O'Dell 1985: 466; Dinnsen 1985: 277) to more lenient views (Winter & Röttger 2011). The concept of incomplete neutralisation received some criticism, especially with respect to methodical issues (for discussion see, e.g. Ernestus 2011 and Winter & Röttger 2011). In particular, it was criticised that the test subjects were confronted with written material. Since neutralisation is not reflected in the spelling of at least some of the languages investigated, critics cast doubt on the existence of incomplete neutralisation, suggesting that the measurements merely reflect hyper-correct articulation of the speakers (cf. e.g. Fourakis & Iverson 1984; Iverson & Salmons 2011). The issue is unresolved; however, the influence of the spelling cannot be held responsible in all cases. Given that phonological rules apply prior to their phonetic implementation, these findings are unexpected.[191] As a consequence, the question arises whether the categorial assumptions of phonology are a suitable model at all.

Dinnsen (1985: 271) proposes a taxonomy of possible types of neutralisation. His key question is whether there are "production differences perceptible or discriminable". Despite the measurable differences in production, one may state that neutralisation is only incomplete if the differences are perceived by the listener. Taking production and perception differences into account, Dinnsen (1985) establishes four logically possible neutralisation types, shown in Table 10 below.

[191] It is therefore somewhat surprising that these findings have not shaken the categorial world of phonology. In her profound study on theories of German final devoicing, Brockhaus (1995: 248) notes that the consequences imposed by incomplete neutralisation could have been serious, if they had had a "perceptible effect on phonological debate." That this did not happen was at least partly due to the fact "by the time Dinnsen made his claims, neutralisation by that name was already playing a substantially reduced role in mainstream phonological thinking". Rather, phonological theory was concerned with Structure Preservation.

Type	Production differences	Perception differences
A	No	No
B	Yes	No
C	Yes	Yes
D	No	Yes

Table 10: Four types of neutralisation according to Dinnsen (1985: 274; slightly modified)

For obvious reasons, type D is impossible and thus unattested.

Type A reflects the standard assumption in phonology that neutralisation is phonetically complete. The output forms are identical acoustically and consequently indistinguishable for the listeners. Instrumental studies have challenged this view, finding that neutralisation is often incomplete.

In type B cases, two acoustically distinct outputs are considered equivalent by the listener. Labov et al. (1972: 229) report that speakers of New York City consistently differentiate between words such as *sauce* and *r*-less vocalised *source,* however, listeners apparently perceived the statistically significant distinction as "the same". Braver (2014) describes a similar case on tapping in American English. This, of course, would shift the – essentially unresolved – question of whether phonological rules are concerned with perception or production to the perception side, or, as Dinnsen (1985: 271) puts it, any "production differences would, therefore, be viewed as linguistically irrelevant." He points out that such a conception would have unwanted repercussions as regards the description of allophonic variation. Since native speakers of a language are seldom aware of allophonic variation, and the differences are not salient perceptually, phonologists could no longer include allophony into their phonological statements. As recognised by many (e.g. Dinnsen 1985: 275), type B cases "find empirical support" in connection with sound changes. Many researchers have pointed to the relationship between incomplete neutralisation and near merger. While the former refers to the synchronic collapse of contrast, the latter characterises diachronic change. Sound change often is the result of the collapse of formerly contrastive sounds that are perceived as equal. As a consequence, they merge into a single category (Hyman 1976; Kiparsky 1995, 2015, 2016).

Type C constitutes cases of non-neutralisation. In effect, the description matches what is typically considered a phonemic contrast. However, as has been put forward by several perception studies, listeners are often able to identify putatively neutralised tokens with an above chance frequency (cf. e.g. Port et al. 1981; O'Dell & Port 1983 on final devoicing in German).

If we adhere to the notion of "half-fortis", neutralisation under Heusler's Law is truly incomplete. Taking the impressions of many dialectologists seriously, it is type C of Dinnsen's taxonomy. According to their descriptions, the neutralised "half-fortis" is perceptually different from the non-neutralised sound. However, it is unclear whether untrained people actually hear the difference. Neither do we know whether they mentally attribute the neutralised sound to the singleton (108)a) or the geminate (b). Perception studies are needed to shed light on the matter.[192]

(108)	a.	singleton	neutralised	geminate
	b.	singleton	neutralised	geminate

The focus of incomplete neutralisation has been on final devoicing, but it is reported in other areas as well (Yu 2011: 1906). Still, most of the studies are concerned with the neutralisation of segmental contrasts and only few works deal with suprasegmental contrasts. For Cantonese, Yu (2007) found incomplete neutralisation between derived and non-derived tones. A few studies have been conducted on vowel length (see Braver & Kawahara 2014 for an overview). One of the few exceptions is Braver & Kawahara (2014) on Japanese vowel lengthening. In Japanese, vowels undergo lengthening due to a bimoraicity requirement. They investigated whether derived long vowels in Japanese have the same duration as underlyingly long vowels. Measurements revealed that lengthened vowels are shorter than vowels that are inherently long. This is an interesting result; in particular, as the authors point out, since MSL clearly is phonologically conditioned.[193] This makes it difficult to simply dismiss variation as postlexical phonetic antics. To my knowledge, no work has been done so far on consonant length.

[192] In a preliminary experiment, Zihlmann (2017) measured the perception rate of initial stops preceded by (amongst other contexts) the definite article (which results in total assimilation, cf. 2.4.1). His results show that his informants (11 in total, one of them speaker of ZG) could correctly identify the *fortis* consonant more often, which he attributes to the fact that the neutralised stops "sounds like a *fortis*", which would speak in favour of (108)b). Zihlmann further notes that on average, identification was above chance level.

[193] Braver (2019) provides an optimality-theoretic analysis of the data.

5.1.4. On the function of neutralisation: Silverman (2012)

In his study on neutralisation, Silverman (2012) focuses on the question of whether the suspension of contrasts is indeed problematic for language users in that it lowers the function of language to convey information. For Silverman (2012: xi), a neutralised contrast can be either *function-neutral,* i.e. it does not affect the semantic load, or *function-positive,* i.e. it may support the parsing of a speech stream by providing clues about word and morpheme boundaries. Lastly, neutralisation can be *function-negative,* i.e. it leads to semantic misinterpretations. Based on this tripartite division he proposes a very narrow definition of neutralisation – which he terms NEUTRALIZATION in small capitals – as "derived homophony" (p. 4) that is, NEUTRALIZATION is restricted to function-negative instances. According to Silverman (p. xi), NEUTRALIZATION is "rare". Under this definition, then, the suspension of contrasts poses no threat to a language (user) as long as it leaves semantic distinctions intact. In fact, Silverman (2012: 198), who takes a decidedly functionalist view, assumes that contrasts below the lexical-morphemic level remain unnoticed by the language user unless "there is evidence from alternation [i.e. from derived homophony] to do so".

Apart from Silverman's theoretical premises, many of which I do not share,[194] two aspects deserve closer attention. Firstly, the fact that many neutralisation phenomena do not put semantic distinction at risk may explain the frequency of neutralisation phenomena in the world's languages. Elaborating on work by Martinet (1952) and Labov (1994), Silverman (2012: 149) hypothesises that a language tolerates "variation in speech [i.e. neutralisation of segmental contrast]" as long as semantic distinctions are maintained. If, however, neutralisation leads to semantic misperception, "anti-homophony" operates, a "passive … pressure towards homophone avoidance" (p. 120). Secondly, Silverman correctly stresses the function-positive traits of neutralisation: limited to certain positions, neutralisation can serve as an aid to the parsing of the speech stream. In this regard, neutralisation has a deliminative function as it signals (word) edges.

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194 Silverman (2012: 7) adheres to a claim he made earlier in Silverman (2006) that "there is no reason to assume that language users subdivide the words they learn into distinct sound-components unless there is evidence from alternation to do so." Thus, he dismisses with formalist concepts such as features or underlying representations; in fact, he takes a decidedly non-segmental view maintaining that segments are "a theoretical construct we will abandon" (p. 15). See Eliasson's (2014) review for some arguments in favour of the segment as a notion accessible to language users, as well as the vast and compelling evidence from psycholinguistic research that phonological information is independently stored in the mental lexicon.

As for ZG, it is difficult to establish how seriously (function-negative) neutralisation affects semantic distinctions. Heusler's Law predominantly operates at morpheme (including word) boundaries. Although Heusler's Law leads to alternations within the verbal paradigm, there is virtually no homophony.[195] (109) shows that candidates for function-negative neutralisation are not unusual across word boundaries. However, the meaning can generally be disambiguated by the context. Additionally, cues such as sentence stress may further help to avoid homophony.

(109)	əs pɛːrli – əs pːɛːrli	'a bear (dim.) – a pair (dim.)'
	fiʃːpɒːr – fiʃːpːɒːr	'fish bar – fish pair'
	uːfplyə̯tː – uːfpːlyə̯tː	'flourish (3.sg.) – flourished (p.p.) [lit. up-blossom]'
	rɒːt suə̯xə – rɒːtː suə̯xə	'look for the bike – seek advice'
	xɒ ʃtamp͡fə – xɒʃ tamp͡fə	'can (1./3. sg) stamp – can (2.sg.) steam
	tːuə̯ ʃtelə suə̯xə – tːuə̯͜ʃ telə suə̯xə	'do (1.sg) jobs search – do (2.sg.) dents search'
	xɒ ʃpriŋə – xɒʃ priŋə	'can (1./3. sg.) run – can (2.sg.) bring'

Turning to the second point, the neutralised instances often (yet not exclusively) occur between words or morphemes and thus may in fact signal word or morpheme boundaries. Future research will determine whether listeners discern a difference between such "minimal pairs". If so, the question arises whether understanding is actually facilitated. As can be gleaned from (109), the neutralised instances may signal morphological edges, yet it remains unclear where the boundary actually is. If the context does not disambiguate, the homophony persists.

In sum, Silverman's (2012) proposal may answer the question of why there is no clearer tendency to avoid neutralisation. However, it does not explain why a contrast is suspended in a particular environment and kept in another. That is, why the supposed importance of the deliminating – i.e. function-positive – role of neutralisation is restricted to obstruent clusters. Moreover, the notion of neutralisation as mere variation of speech should be called into question. Neutralisation is not optional and may or may not apply freely as long as it does not jeopardise semantic contrast. While there are instances of neutralisation related to speech rate and register, Heusler's Law applies in any case. Thirdly, Silverman's functional explanation is incapable of accounting for the actual phonetic output. Obstruent cluster neutralisation may intuitively seem "natural", in the sense of "least effort". In optimality-theoretical approaches (e.g. Boersma 1998; Kirchner 1998, 2000), *EFFORT – or its counterpart

[195] Despite the vast number of minimal pairs (cf. 2.3.1), there practically no minimal pairs where both members are verbs. Note that the minimal pair /retə/ 'speak – /retːə/ 'save' is disambiguated in the paradigm by epenthesis: [retʃ] 'speak (2.sg.)' – [retːiʃ] 'save (2.sg.).

LAZY – have been used as constraints that reduce the articulatory effort. Such a constraint obviously is in conflict with constraints that ensure distinction (i.e. faithfulness constraints). In his broad survey of a variety of lenition phenomena, Kirchner (1998) concluded that lenition is a direct consequence of the interaction between LAZY and faithfulness constraints. In the case of geminates, the high ranking of *EFFORT leads to lenition. After examining 272 grammars, Kirchner (1998: xiv) states that geminate stops "never lenite unless they concomitantly degeminate". With regard to Heusler's Law, this observation deserves closer scrutiny. On the one hand, neutralised geminates are considered shorter than non-neutralised geminates, however, they are not identical to a singleton. On the other hand, singletons are longer when neutralised. This suggests that both the articulation of the geminates and that of the singletons requires more effort compared to the neutralised form. Such an assumption seems obvious in the case of geminates. For singletons, however, the notion "less effort" needs to be clarified. I leave it open for future research.[196]

5.1.5. Summary

The previous sections presented theoretical approaches to neutralisation. I took Trubetzkoy's typology as a starting point because most of the later work on neutralisation is limited to phenomena that can be accounted for in the context of markedness theories. Trubetzkoy, however, also allows for the possibility that the neutralised sound may differ from the non-neutralised sounds. Heusler's Law seems to represent such a case.

In addition, two other approaches were briefly discussed, namely the "syllable-based" and the "cue-based" approach. One main argument for the latter is that it makes different predictions for final and medial coda consonants. It cannot be decided which of the two approaches is superior; in some languages, prominence appears to be linked to the prosodic structure, while others function linearly. Regarding Winteler's Law, the syllable seems to play an essential role. In the case of Heusler's Law, both approaches reach their limits: Heusler's Law affects onset and coda consonants alike, which speaks against a syllable-based approach. In a cue-based account, on the other hand, we would not expect both elements of a cluster to be of equal prominence, either.

[196] As a final note, it should be mentioned that studies on geminates are limited to intersonorant contexts. Languages that permit obstruent clusters and at the same time have a singleton/geminate contrast seem to be rare in the world's languages.

Recently, the question has arisen as to whether "real" neutralisation exists at all. Empirical studies have challenged this assumption. An important distinction associated with incomplete neutralisation is whether the acoustically measurable contrast is perceived.

Crucially, most of the work on neutralisation relates to segmental phenomena (with the exception of Silverman who takes an entirely different view). Since ZG has a singleton/geminate contrast, the question arises what neutralisation of suprasegmental contrasts looks like. This question will be discussed in more detail in the following sections.

5.2. Neutralisation of suprasegmental contrasts

The studies reviewed in the previous section are mainly concerned with neutralisation phenomena to account for markedness relations. Consequently, they concentrate on Trubetzkoy's type 3 – and to some extent on type 2 –, where the neutralised element is identical to one of the opposition members. Phenomena in which the neutralised element differs from both opposition members (i.e. type 1 in Trubetzkoy's typology) are largely neglected.

Chapter 4 showed that ZG has a singleton/geminate contrast. A segmental explanation for neutralisation of Heusler's Law is therefore not available. Nevertheless, before going into the modelling of neutralisation of suprasegmental contrasts, I will first sketch what an analysis in segmental terms would look like. Since standard theories regard neutralisation as the suspension of a contrast in favour of the unmarked value, Trubetzkoy's type 1 is unforeseen in these approaches.

The remaining sections will deal with neutralisation of suprasegmental contrasts. Neutralisation can be modelled in both X-Theory and Moraic Theory. In X-Theory, neutralisation is the deletion of an X position (stray erasure) under certain templatic conditions. This approach is advocated in the work of Kraehenmann (1996, 2003) on Thurgovian, which I will discuss in 5.2.3.

5.2.4 shows how Moraic Theory handles neutralisation. Crucially, Moraic Theory accounts for neutralisation by referring to prosodic positions. In a language (like ZG) with WbP, geminates in coda position cannot be distinguished from the singletons associated with a structural mora. For Thurgovian, Kraehenmann (2003) bases her claims against moraic geminates on two main observations, which are discussed in more detail in 7.2.4.1 and 7.2.4.2. I will argue that, paradoxically, Kraehenmann's line of reasoning speaks in favour of a mora-based analysis of ZG.

A final comparison is made in 5.2.5. It turns out that the two theories come to very different – not to say opposite – conclusions. The section sums up the arguments put forward in favour of Moraic Theory. It also critically reviews some open questions. Finally, an outlook is given on the predictions Moraic Theory makes for the phonetic investigation.

5.2.1. Heusler's Law in a segmental analysis

On a mere descriptive level, Heusler's Law is straightforward: adjacent obstruents coincide in an intermediate value. However, Heusler's Law causes some principled problems with concept of neutralisation, if we adhere to the standard definition that underlying contrasts are neutralised in favour of the unmarked value (cf. Hall 2000: 97). This section discusses how Heusler's Law could be accounted for in a segment-based analysis. In doing so, we obviously reintroduce the problems described earlier in Chapter 3, which have led to a departure from the *fortis/lenis* distinction. With the return to *fortis/lenis,* the connection between *fortes* and moraicity becomes less straightforward; weight-related processes cannot be directly explained using the feature *fortis*.

Even if we accept these premises, the problem persists that the neutralised value is "somewhere in between". Therefore, *fortis/lenis* cannot be a binary (nor a privative) opposition. Analyses that capture Trubetzkoy's type 1 are most readily found for vowel systems. In principle, two lines of argument are available. The first approach utilises a combination of binary features. The second posits multivalued features. I will briefly discuss them in turn.

Multilateral oppositions can be treated by a set of discrete binary oppositions. Thus, a language with three opening degrees of the front vowels /i e a/ has the following feature matrix:

(110)

	high	low
i	+	–
e	–	–
a	–	+

In the case of the *fortis/lenis* opposition, we could posit a feature matrix as in (111).

(111)

	[fortis]	[lenis]
“fortis”	+	–
“lenis	–	+
“neutralised”	–	–

(111) implies that *fortis* and *lenis* are no longer in bilateral opposition. This is reminiscent of how gradual oppositions can be treated in a binary system (see fn. 183). Contrary to (110), however, the sound specified for [- fortis, - lenis] is not a phoneme. We thus have to introduce an unmotivated phoneme in order to achieve an intermediary sound.

Furthermore, it is unclear how Heusler’s Law should be formulated. Since any combination of *lenis* and *fortis* results in neutralisation, we cannot posit an assimilation process (see, however, below). Instead, we would have to stipulate that, for some reason, positive values are prohibited in obstruent clusters. Since neither *fortes* nor *lenes* are allowed, a rule (or a constraint) had to be postulated that ensures that in obstruent clusters, the values are set minus.[197]

Instead of proposing specifications for individual heights and differentiate them by ‘±’ values, we could instead regard height itself as the sole parameter and assign it numerical values on a scale. This, of course, reflects the intuition that gradual oppositions are located on a continuum. A vowel system that differentiates four degrees of apertures is shown in (112).

[197] The same applies to the feature [± long] as proposed in Haas (1978).

(112)

4	i
3	e
2	ɛ
1	a

High

Lass (1989: 105f.) gives Middle English as an example. In Middle English, vowels were lowered by one height in a particular environment, thus [i] → [e], etc.[198] If we incorporate the height values of (112) into the rule, the generalisation falls out naturally: [n high] → [n-1 high]. Such an analysis, however, is not an option in the case of the *fortis/lenis* distinction. Again, the difference is that the neutralised value (which would probably be assigned a 2 value on the continuum) has no phonemic status.

A novel proposal is Iverson & Salmons (2007) who suggest two processes: final fortition and feature spreading. Although final fortition is viewed as feature addition (i.e., the final consonant is specified for [+ fortis]), they motivate it on diachronic and prosodic grounds. Drawing on Blevins's (2006) approach of Evolutionary Phonology, they suggest that final fortition started out as a prosodic marker in word-final position and made its way "from utterance- or phrase-final position through word-final position, generalising finally to syllable codas" (p. 14). Crucially, the opposition member that occurs in positions of neutralisation is the phonologically marked member of the opposition.

> The view we are developing here … accords a higher role to final aspiration, *viz.* serving the function of marking the end of a phrase or word, and, in the case of German, as we shall show, marking the end of the syllable through neutralisation to the fortis series, whether released with aspiration or not. The product of these neutralisations to aspirated or fortis obstruents thus remains phonologically marked, a price the phonology appears willing and able to pay for having the grammar meet the goal of distinctive marking of the ends of prosodic units.
>
> Iverson & Salmons (2007: 9)

For SwG, the authors propose that final fortition is followed by the feature spreading of the [fortis] feature:

> Tellingly, initial position shows a progressive sandhi-level spread of fortis character, where an initial lenis is written as lenis after a sonorant consonant or

[198] The circumstances are more complex; however, it is not significant to the point made here.

> vowel, but as fortis after any fortis obstruent, including those arising via final fortition of phonologically lenis stops […]
>
> Iverson & Salmons (2007: 16)

Iverson & Salmons (2007: 16) present evidence from Notker's *Anlautgesetz,* which they view as a predecessor of Heusler's Law. In Notker's texts, initial *lenis* sounds are spelt as *fortis* when they occur after an obstruent. Examples are given in (113). The letters in question are put in boldface.

(113)	ter **b**ruoder	'the brother'	des **p**rûoder	'of the brother'
	demo **g**ólde	'with the gold'	tes **k**óldes	'of the gold'
	unde **d**az	'and that'	íst **t**as	'is that'

Heusler's Law is indeed reminiscent of Notker's *Anlautgesetz,*[199] which suggests that Iverson & Salmons's analysis would be the same: final obstruents were neutralised as *fortis* in order to signal a prosodic boundary. Once the feature is set, it spreads onto the following onset. Referring to Blevins's (2006) evolutionary approach, they conclude that while neutralisation usually favours the unmarked member, the other direction is not ruled out.

Iverson & Salmons clearly deserve credit for calling into question the traditional view that marked opposition members are disallowed in positions of neutralisation. Furthermore, it is the first analysis to provide phonological arguments to account for the fortition of initial obstruents in Notker's *Anlautgesetz* as well as in Heusler's Law. However, the authors offer no explanation for the distinction between *fortis* and *lenis* obstruents in SwG dialects. While their arguments on StG final devoicing are rooted within segmental phonology, the features *fortis/lenis* in SwG are less than clear. If we adhere to the assumption that *fortis/lenis* is a singleton/geminate opposition, the argument falls apart, since there is no feature to spread. In addition, with the exception of the alveolar fricatives (cf. 2.4.1), ZG has no progressive assimilation.

5.2.2. Heusler's Law as prosodic neutralisation

In an analysis (like the present one) which assumes a singleton/geminate contrast, the segmental structure of the phonemes involved is irrelevant. On the segmental tier, singletons and geminates are the same. The representations in X-Theory and in Moraic Theory are repeated below. In a skeletal approach, the difference between singletons

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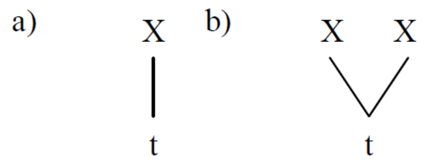
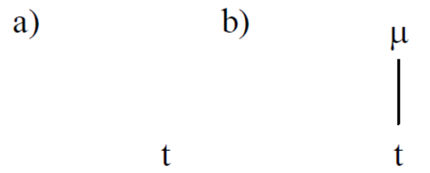
199 In fact, Heusler (1888: 27) puts his observations on Basle German in the context of Notker's *Anlautgesetz*. Similar arguments were brought forward by Moulton (1979), Lahiri & Kraehenmann (2004) and Page (2013).

and geminates is that the latter is associated with two X positions, while the former is associated with only one, (114). In Moraic Theory, the contrast is represented by the absence (a) or presence (b) of an underlying mora, (115).

(114)



(115)



The two approaches have in common that they cannot relate to segmental material. Their predictions, however, are very different, as will be shown below. For comparison, I will first present the analysis of Kraehenmann on Thurgovian, which is formulated in X-Theory. Kraehenmann gives two reasons why skeletal analysis is preferable to Moraic Theory. I will discuss them both with reference to ZG. Neutralisation in Moraic Theory is presented in 5.2.4. I will argue that an analysis in Moraic Theory is preferable for two reasons. First, weight-related processes are better reflected in Moraic Theory. Arguments for the moraicity of ZG geminates were already presented in 4.3. In 5.2.4, I will add another argument (which Kraehenmann regards as a counter-argument). Secondly, Moraic Theory depicts the phonetic reality more adequately. Trubetzkoy’s type 1 finds a direct representation in Moraic Theory.

5.2.3. Neutralisation in a skeletal framework: Kraehenmann (2003)

To my knowledge, Kraehenmann’s account of Thurgovian (2003) is the only theoretical analysis of SwG neutralisation. Kraehenmann argues that Thurgovian has a singleton/geminate opposition. She employs a skeletal framework, where singletons are phonologically represented by associating the segment to a single X-slot, while geminates are linked to two X-slots, cf. (114). Neutralisation is the deletion of an X-slot caused by templatic restrictions. Kraehenmann (1996, 2003) posits the syllable template in Fig. 11.

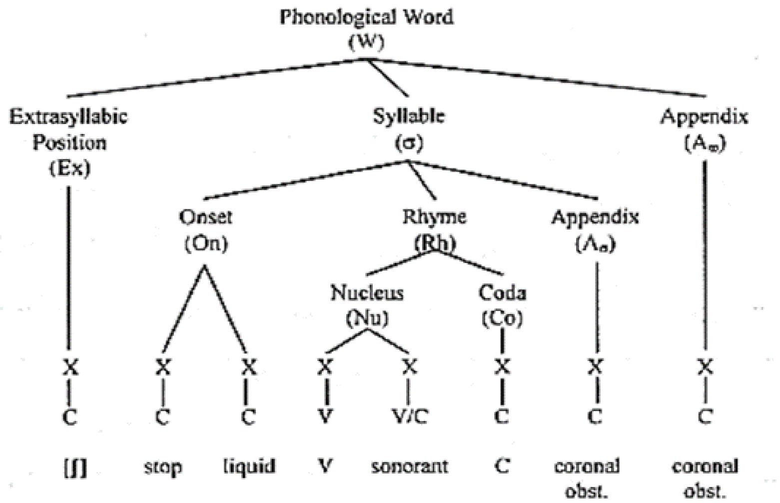
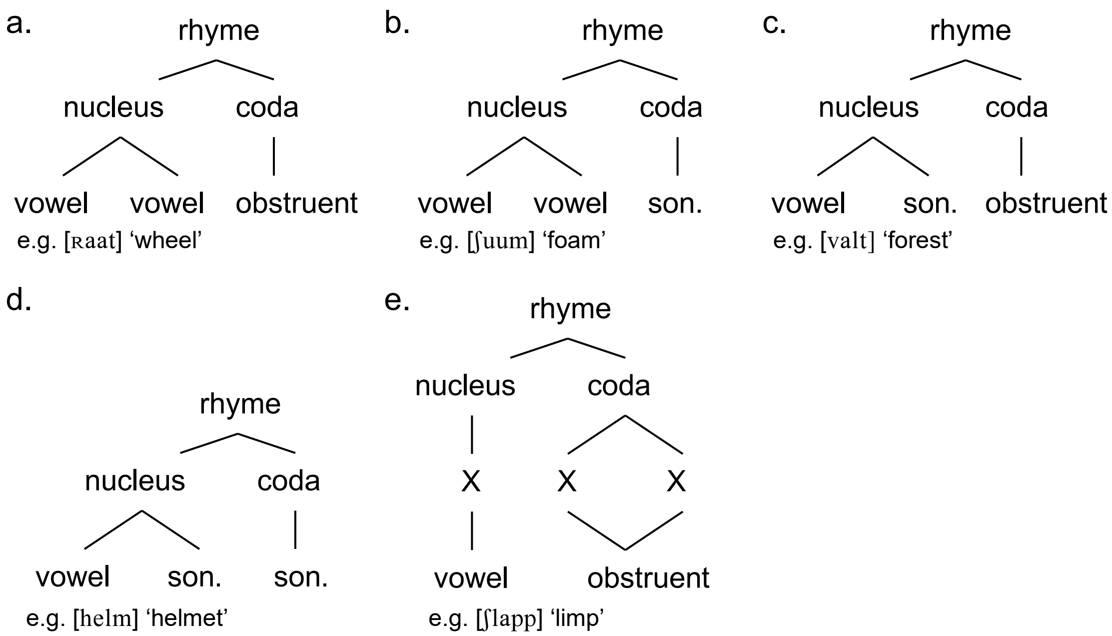


Fig. 11: Thurgovian syllable template (Kraehenmann 1996: 21; Kraehenmann 2003: 10)

Kraehenmann (2003: 12) proposes that Thurgovian rhymes are maximally tri-positional. Evidence comes from the fact that non-final rhymes do no exceed three positions. The possible structures are given in (116) below (son. = sonorant consonant; the examples are from Kraehenmann's word list). The second nuclear position can be filled by either a vowel (a, b) or a sonorant consonant (c, d). Sonorant consonants are in the coda when preceded by long vowels or diphthongs (b), or another sonorant consonant (d). Obstruents are always in coda position (a, c, e). Positing a maximum of three positions implies that either the nucleus or the coda may branch, but not both. According to Kraehenmann (2003), the restrictions are even greater in that branching codas are possible only if the coda consonant is a geminate (e).

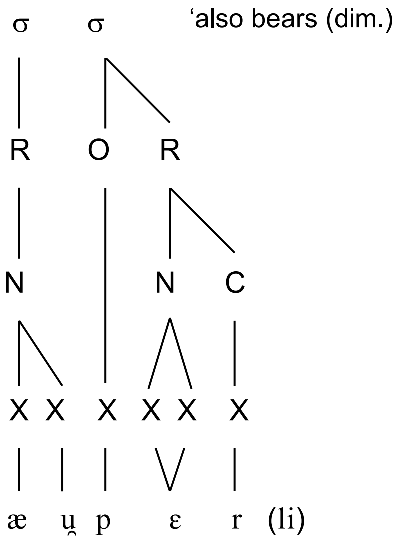
(116)



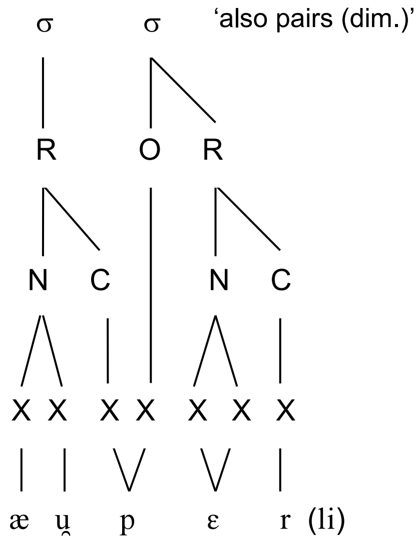
Kraehenmann (2003) assumes that all positions have to be prosodically licensed in order to obtain a phonetic interpretation. Unlicensed positions are deleted by *stray erasure* (Steriade 1982). In order to accommodate both X positions, geminates require so-called *anchor positions*. Whether an anchor position is available depends on the structure of the following (in the case of initial geminates: preceding) syllable. If the templatic conditions are met, the second part of the geminate is free to associate. If the landing-site is already occupied, however, only part of the geminate is licensed. From the templatic restrictions, obstruent cluster neutralisation falls out naturally: geminates that cannot be associated entirely are neutralised. Neutralisation is the elimination of an unassociated X position by stray erasure, which results in a singleton. In X-Theory, neutralisation is lenition.

In the case of word-initial geminates, the singleton/geminate contrast is maintained in intersonorant context, as shown in (117). When two obstruents occur consecutively (118), only one X position is available. The second position of the geminate in (b) is deleted, leading to the neutralisation of the contrast.

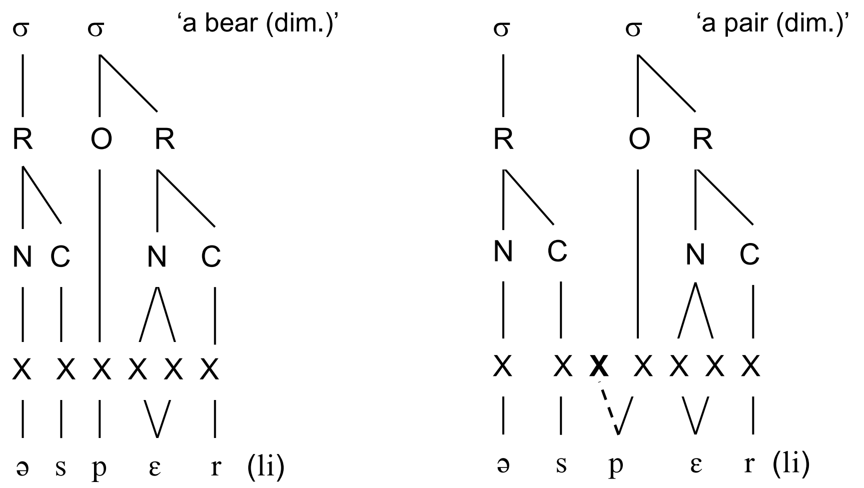
(117) a. singleton



b. intersonorant geminate: both X-positions are licensed



(118) a. singletons b. Geminate after obstruent: only one X position is licensed



X-Theory thus accounts for the neutralisation phenomena in a straightforward way: if the coda position is free, the contrast is maintained. Otherwise, the X position is not prosodically licensed and will be deleted. Neutralisation therefore only affects geminates since a landing position is always available for singletons.

Let us turn to word-final geminates. Acting on the assumption that the syllable template has a maximum of three rhymal positions (plus appendix), Kraehenmann (2003: 31) predicts that

a) X-slots that do not fit into the template are subject to *stray erasure*

b) the singleton/geminate opposition after branching rhymes is maintained at phrasal edges, due to an additional position.

Word-final consonants are neutralised only in phrase-medial position.[200] As shown in Fig. 12, an extra (appendix) position is licensed phrase-finally, allowing for the maintenance of the contrast.

[200] Kraehenmann (2003: 12f.) does not make explicit reference to the Peripherality Condition. Instead, she states that “timing positions at the word margins may remain unassociated until it is clear whether a phonological phrase ends with the completion of the word.”

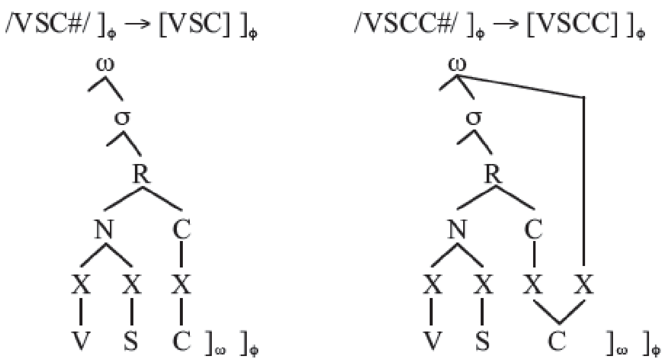


Fig. 12: Phrase-final singleton/geminate contrast after branching nucleus (Kraehenmann 2003: 32; S = sonorant consonant, C = obstruent consonant)

Furthermore, neutralisation only occurs if the preceding nucleus branches (Fig. 13). If the nucleus is non-branching (Fig. 14), the opposition is again maintained.

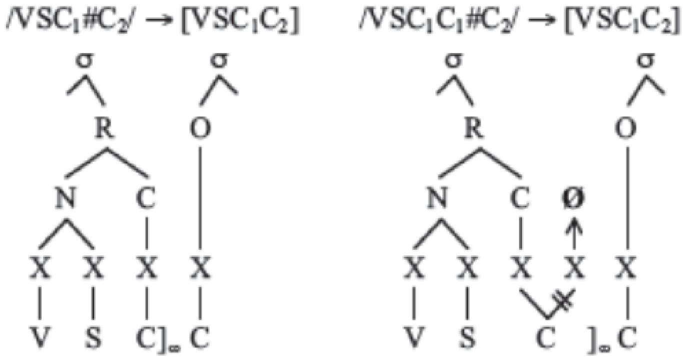


Fig. 13: Phrase-medial singleton/geminate contrast after branching nucleus (Kraehenmann 2003: 124)

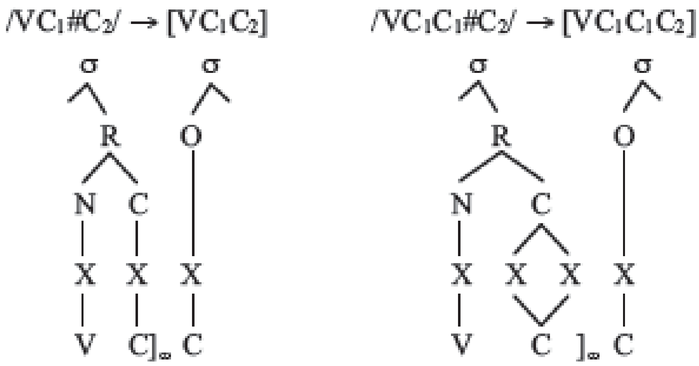


Fig. 14: Phrase-medial singleton/geminate contrast after non-branching nucleus (Kraehenmann 2003: 123)

The prediction is, that neutralisation of obstruent clusters depends on the structure of the preceding nucleus. This is somewhat surprising since it contradicts the traditional view: Heusler's Law predicts neutralisation of adjacent obstruents across the board, whereas the templates above predict the maintenance of the opposition if the nucleus is non-branching. According to Kraehenmann, neutralisation does not occur in the following phrase-medial environments, (119):

(119) a. Word-final obstruents are not neutralised if the preceding nucleus is non-branching.

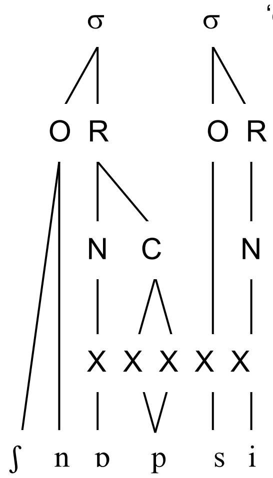
b. Word-initial geminates are neutralised if the preceding nucleus is branching.

From Fig. 14, it can be inferred that the contrast of the word-final obstruent is maintained if preceded by a non-branching nucleus, even if it is followed by another obstruent. The representations in (120) and (121) illustrate this. In (120), both the singleton (a) and the geminate (b) are fully licenced, therefore, the contrast is maintained.

(120) a.

'scratch her (imp.sg.)'

b.



'catch her (imp.sg.)'

Unfortunately, Kraehenmann provides no evidence in support of this claim.[201] Turning to (121) below, we have a geminate after a non-branching nucleus (a), therefore, both X positions are licensed. In (b), the obstruent is a singleton preceded by a branching nucleus. In both cases, all skeletal positions can be anchored. Again, the prediction is that the contrast is maintained.[202]

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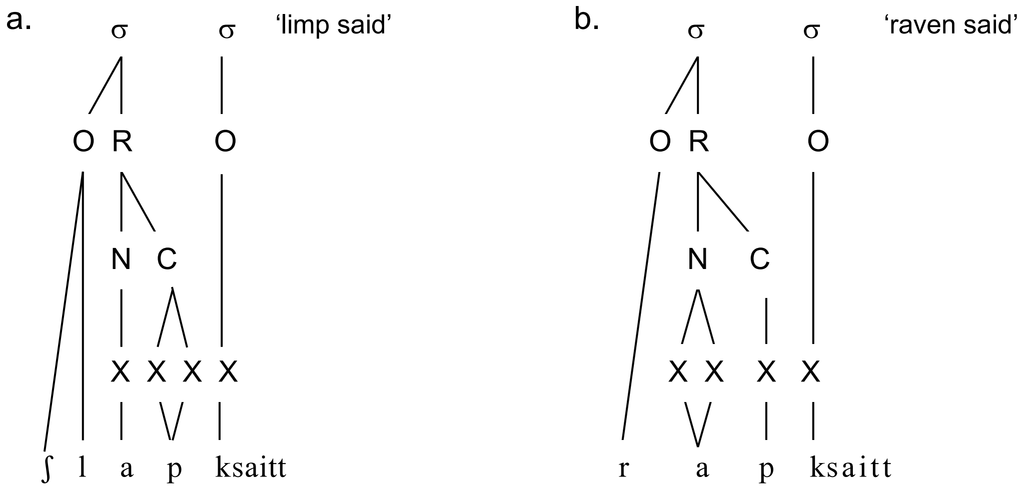
[201] According to Kraehenmann (2003: 122), words of the structure CVC do not occur in Thurgovian. As can be gleaned from the examples above, ZG verbs often take this form.

[202] Kraehenmann (2003: 125) reports for geminate stops in the context V_#C – i.e. (121)a) – a mean closure duration of 118.1 ms compared to 74.5 ms for the singletons in the context VV_#C – i.e. (121)b).

(121)



Let us return to word-initial data and the prediction formulated in (119)b). Assuming a maximum of three rhymal positions, Kraehenmann predicts neutralisation of word-initial geminates, even if they occur in intersonorant contexts. Thus, a word-initial geminate following a word with the rhymal structure VVS should be neutralised because there is no landing position available in the preceding syllable. The prediction is restricted to stops since word-initial fricatives are always singletons (see, however, fn. 34). Kraehenmann (2003: 36) explicitly mentions this prediction. However, she concedes that her corpus does not contain any instances to verify the claim.[203]

Let us briefly summarise what has been discussed so far. In Kraehenmann's approach, neutralisation is achieved by postulating a syllable template which causes unsyllabifiable X-slots to be deleted by stray erasure.

Neutralisation is thus in effect lenition. Under non-neutralising conditions, a singly linked segment is shorter than a segment linked to two timing slots. Kraehenmann (2003: 167) explicitly mentions the relationship between neutralisation and lenition: “All geminates are shortened, i.e., the contrast is neutralised, when adjacent to an obstruent”.

Analysing neutralisation as stray erasure governed by templatic restrictions is undoubtedly very attractive. However, some of the instances are hard to capture. In fact, Kraehenmann's statement quoted above contradicts some of her own predictions:

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203 In my data sample, such instances occur. The items are /pɒsː/ ‘bass’ and /pːɒsː/ ‘passport’ preceded by /ɒrm/ ‘poor’ and /t͡sɒːm/ ‘tame’. Although the data is sparse (N = 31), there is a clear difference between word-initial singleton and geminate stops after three-positional rhymes (mean CD for singletons: 41.8 ms; mean CD for geminates: 129.4 ms). These findings corroborate earlier impressions expressed in Würth (2002: 117). In this non-representative inquiry, I colloquially tested a small number of friends and colleagues whether they could make out a difference between [filmpɒːr] ‘movie bar’ vs [filmpɒːr] ‘movie couple’; [ʋɒrm kɛː] ‘give warm’ vs [ʋɒrm kːɛː] ‘given warm’; [ɛmɒːl pɑxːət] ‘bakes once’ vs [ɛmɒːl pːɒxːətː] ‘baked once’; [ʋil ər xuːm tixtət] ‘because he hardly (ever) writes poetry’ vs [ər hætː xuːm tːixtətː] ‘he has hardly (ever) written poetry’.

as mentioned previously, the adjacency of another obstruent does not cause *all* of the geminates to neutralise, cf. (120) and (121), and predicts neutralisation in an intersonorant environment, cf. (102). Furthermore, the study fails to address the implications of analysing neutralisation as lenition. Modelling obstruent cluster neutralisation as stray erasure predicts that the neutralised consonant is similar to a singleton consonant. This is somewhat surprising given that Heusler and his successors have termed the neutralised sound “half-fortis”, suggesting that the neutralised sounds are “fortified” (rather than “lenited”).

Kraehenmann’s (2003: 125, 148) acoustic measurements are summarised in (122). It shows the mean closure duration (in ms) of word-final stops (a) and the mean segment duration of word-final fricatives (b) in a phrase-medial context in non-neutralising and neutralising environments. The contrast is neutralised, when the following word begins with an obstruent, i.e. _#C (S = sonorant consonant; C = obstruent).

(122)

		no neutralisation				neutralisation	
	environment	S_#V	S_#S	VV_#V	VV_#S	S_#C	VV_#C
a.	singleton stop	49.2	69.3	54.8	63.5	69	74.5
	geminate stop	110	96.9	141.8	112.5	66.1	83.9
b.	singleton fricative	94.6	102.9	104.3	94.6	108	123.3
	geminate fricative	130.5	122	157	147.2	117.7	132

The results leave a somewhat scattered picture. Clearly, neutralised geminates are shorter than non-neutralised, as the theory predicts. They are, however, still longer than their non-neutralised singleton counterparts. In addition, neutralised singletons are longer than non-neutralised singletons. Clearly, this is unexpected for an analysis that regards neutralisation as lenition. Kraehenmann offers no explanation for these differences. I assume that they are considered mere phonetic variants that are of no concern to the phonology of Thurgovian.

Finally, it is unclear how Winteler’s Law is dealt with in an approach that views neutralisation as stray erasure. Winteler’s Law is not the focus of Kraehenmann’s research and is therefore not mentioned. There may be no lengthening of sonorants in coda position in Thurgovian. Likewise, there may be no alternations in the verbal paradigm. Since Winteler’s Law clearly involves lengthening, an explanation using stray erasure – as assumed for Heusler’s Law – seems impossible. As we will see in the next section, Moraic Theory captures them both in a unified manner.

5.2.4. Neutralisation in Moraic Theory

This section presents an account of Heusler's Law in Moraic Theory (Hayes 1989, 1995). It is the core of this thesis, the main argument being that in Moraic Theory, the neutralisation of singletons as fortition can be explained in a straightforward way.

The line of reasoning in this section follows, in essence, work presented earlier (Seiler & Würth 2008; Würth 2017). Apart from Kraehenmann (2003), there are virtually no phonological studies on neutralisation in Swiss German dialects. A similar proposal to the one presented here is sketched in Page (2001: 241f.). To my knowledge, no other work on ZG neutralisation exists, and the argument presented here has not been pursued so far.

Kraehenmann (2003) puts forward two main arguments in favour Skeletal Theory over Moraic Theory. First, she points out that, contrary to X-Theory, Moraic Theory fails to distinguish inherently moraic segments from those associated with a structural mora. Second, she argues that (obstruent) geminates in Thurgovian have no impact on stress assignment. This is in line with the criticism brought forward by Tranel (1991) discussed previously in 4.2.1.1: since geminates are lexically moraic in Moraic Theory, the prediction is that syllables closed by a geminate are heavy and thus attract stress. According to Kraehenmann (2003), geminates in Thurgovian are not weight-contributing. The predictions made by Moraic Theory would thus lead to false statements. I will address her arguments in turn.

5.2.4.1. Coerced weight and distinctive weight (Morén 1999)

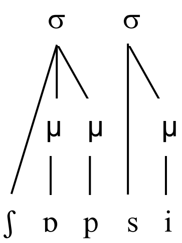
As mentioned previously (cf. 4.2.1), moraic consonants come from two different sources: geminates are assigned a mora at the level of underlying representation. Singletons are assigned a structural mora when in coda position (Weight-by-Position). On the surface, geminate and singleton coda consonants therefore look the same.

The fact that in word final position "a rhyme made heavy by Weight-by-Position looks exactly the same as a rhyme made heavy by an underlying geminate" is problematic in Kraehenmann's (2003: 24) view. She thus raises the question of "how can such final sounds be represented in a language that distinguishes between [pap] and [papp]?"

The claim pursued here is that such instances are not disambiguated at all. ZG has both WbP and word-final lexical geminates. The data presented in 4.3 provide clear evidence that coda consonants contribute to syllable weight and are therefore moraic. The long-held view that neutralised obstruents are "fortified" provides additional support that singletons are longer in coda position. Moraic Theory thus predicts that inherently moraic consonants (i.e. geminates) and positionally moraic consonants are distinct only at the level of underlying representation but are similar for phonetic interpretation. In fact, for languages that exhibit both geminates and WbP, Moraic Theory predicts neutralisation in Coda position.[204] If there is a difference between structural and inherent moras, as Kraehenmann suggests, this would pose a severe problem for Moraic Theory. In a pilot study on Winteler's Law, Seiler & Würth (2008) provided evidence that the predictions made by Moraic Theory are corroborated by phonetic measurements (cf. 6.1). In the following, I will argue that the assumptions of Moraic Theory also apply to Heusler's Law.

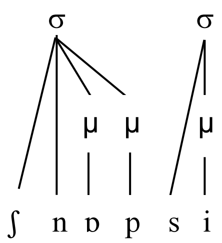
The strengthening of obstruents in coda position can thus be described as positional neutralisation: coda obstruents are assigned a mora by Weight-by-Position. In this analysis, the parallelism of (120) – repeated here in the moraic framework as (123) – falls out naturally:

(123) a.



'scratch her (imp.sg.)'

b.

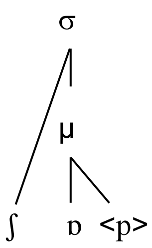


'catch her (imp.sg.)'

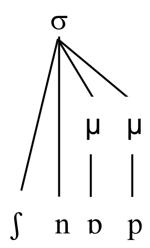
In (123)a), the underlying form is /ʃɒp/ and the mora is assigned structurally. In (b), /ʃnɒpː/ contains an inherent mora. On the surface, they do not differ.

In word-final position, there is a distinction because the final consonant is extrametrical, if it is a singleton (124)a). Geminates are incorporated into the syllable (b).

[204] Cf. Riad (1995: 168), for a similar analysis of Swedish and Norwegian. Ham (1998: 21) predicts that languages with final geminates mark final singletons as extrametrical in order to maintain the distinction. To my knowledge, this prediction has not been tested exhaustively so far. Hams own study includes Bernese, Levantine Arabic and Hungarian, all of which treat final singletons as extrametrical.

(124) a. 

'scratch (imp.sg.)'

b. 

'catch (imp.sg.)'

Neutralisation in (123) is a direct consequence of the collapse of lexical and structural moras. The same argument is made by Morén (1999), who makes a distinction between distinctive vs coerced weight.[205] Distinctive weight differences stem from inherent moraicity, whereas coerced weight emerges from phonological processes. Crucially, coerced weight only appears as a result of higher prosodic demands, such as word minimality, Stress-to-Weight ("stressed syllables must be heavy", Hayes 1995; Kager 1999), or Weight-by-Position. Given the completely different functions of inherent and coerced weight, we would expect differences between the two types of moraicity. Morén (1999) showed that while Weight-by-Position prefers more sonorous consonants, sonorous (lexical) geminates are less preferred cross-linguistically. Drawing on work by Zec (1988, 1995), Morén (1999: 15f.) recognises a close connection between coerced weight and sonority: the higher the sonority of a sound, the more likely the application of WbP. No such connection can be established for distinctive weight: lexical moraicity is independent of sonority. Conversely, consonants can receive a mora under coercion even if there is no lexical contrast between singleton and geminate consonants. Since the assignment of coerced moras is a consequence of higher prosodic conditions, moraicity under coercion is never distinctive. Rather, it leads to alternations as we find them in Weber's description of ZG long and short sonorants.[206]

Coerced weight and distinctive weight can interact. In ZG, this is apparent in two areas. We have already discussed the first case in (123) above, where inherent moraic segments coincide with segments that become moraic via WbP. It is noteworthy that there is a clear structural difference between inherent and structural consonants:

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205 Distinctive and coerced (or coercive) weight corresponds to what I dubbed inherent/lexical vs structural moras. In the present thesis, the terms are used synonymously.

206 Morén's (1999: 16) implicational relationship between sonority and moraicity is formulated as follows: „If α is moraic under coercion, then β is moraic under coercion if β is more sonorous than α." As I have mentioned previously (cf. fn. 125) the formulation does not quite hold for ZG. ZG clearly has moraic consonants under coercion, however, the most sonorous consonant, the rhotic /r/, is excluded from moraicity. In fact, as suggested in Page (2001), it triggers lengthening of the preceding vowel, exactly because /r/ is barred from being moraic.

structural moras are restricted to the coda. Thus, while distinctive moraicity may surface as a heterosyllabic geminate word-medially, coerced consonants never have a ‘flopping’ structure. A second case for the overlap of lexical weight and structural weight concerns the vowels. In monosyllabic words, the underlying length contrast is neutralised. Long vowels are either inherently long (125)b) or result from MSL (a).

(125) a. /hɒs/ → [hɒːs] ‘rabbit’ [hɒsə] ‘rabbits’
b. /huːs/ → [huːs] ‘house’ [hyːsər] ‘houses’

Morén couches his analysis in an OT framework (Prince & Smolensky 1993). OT differentiates between two major types of constraints: Markedness constraints push output forms towards unmarked types of structure, whereas faithfulness constraints ensure the preservation of lexical contrasts. Since there is an inherent conflict between markedness and faithfulness constraints, it is logically impossible for an output candidate not to violate any constraints.

In OT, neutralisation of a contrast is modelled as a specific ranking of constraints; faithfulness constraints ensure lexical contrasts in some positions but are overridden by markedness constraints in others. Again, neutralisation is regarded as “the unmarked”. In the case of final devoicing, the faithfulness constraint that ensures the maintenance of contrast is dominated by a context-sensitive markedness constraint *VOICED-CODA (Kager 1999: 40), which penalises voiced codas.

The distinction between coerced and distinctive weight has the following implications: distinctive weight is inherent; thus, any constraint that ensures the preservation of a lexical contrast is a faithfulness constraint. Coercive weight, on the other hand, is driven by markedness constraints that put pressure on the language to minimise the markedness of a linguistic unit. In what follows, I will not give a detailed description of Morén’s analysis but focus on the aspects that are relevant for ZG. The constraints responsible for lexical contrasts are faithfulness constraints that ensure that the output corresponds to the underlying representation (so-called IDENT(ity) constraints, cf. e.g. Kager 1999: 269). They can be split into two major subgroups: DEP-IO and MAX-IO. (126) lists the most important constraints for our purposes. They are explained below.[207]

[207] Strictly speaking, Morén’s (1999: 37ff.) main focus is not on the identity constraints as such, but on the faithfulness of the associations (Linking Constraint, cf. fn. 118). This ensures that not only the number of moras is kept constant, but also the associations remain unchanged.

(126) DEP-μ-IO: Output moras have input correspondents (“no mora insertion”)
MAX-μ-IO: Input moras have output correspondents (“no mora deletion”)
FTBIN: Feet are binary at either the syllabic or moraic level
WBP: Coda consonants are moraic

DEP-μ-IO makes sure that the output has an input correspondent (“no insertion”) and MAX-μ-IO requires all the input material be present in the output (“no deletion”). With regard to moraicity, both constraints block the insertion or deletion of moras. If undominated by any markedness constraints, no moraic consonant other than geminates would ever surface. ZG, however, allows structural moras in the output. This means that there are markedness constraints ranked above faithfulness constraints. The markedness constraint responsible for MSL is FTBIN, which requires feet to be bimoraic either by consisting of a single heavy or two light syllables. MSL is an instantiation in order to satisfy this constraint. The addition of a mora is coerced by FTBIN, violating the constraint that opposes insertion. FTBIN is thus ranked above DEP-μ-IO. The second markedness constraint is WBP, which requires coda consonants to be moraic. Like FTBIN, WBP must be ranked above DEP-μ-IO, otherwise there would be no coerced moras in the output. Vowels, on the other hand, never shorten. Thus, MAX-μ-IO is undominated.

Positional neutralisation is expected in the following environments: first, in monosyllabic words ending in a singleton obstruent. The fact that the underlying vowel in (125) above is short in (a) and long in (b) can be inferred from the paradigmatic alternation.

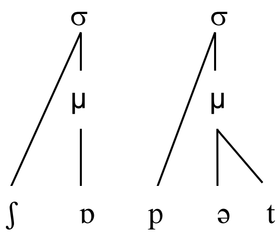
Second, we expect neutralisation when coerced weight via WbP coincides with word-final geminates. I have stressed previously that word-final singleton obstruents are not subject to WbP as they are set extrametrical, (124). We find neutralisation in obstruent clusters such as /sɒft/ ‘juice’ or /xræps/ ‘crab’. The first obstruent surfaces as moraic through WbP. In fact, no differentiation between hypothetical /sɒft/ and /sɒfːt/ is possible. The output form is always moraic and of an intermediate duration [sɒfˑt].

In paradigms, however, we find alternation. The first column in (127) shows the verb stem. In (a), a vowel-initial inflectional ending is added, placing the stem-final consonant in intervocalic position. With the addition of a consonantal morpheme, as in (b), the stem-final consonant is in a position where WbP applies.

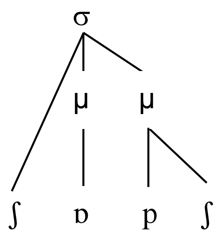
(127)	/ʃɒp/	a.	/ʃɒp/+/ət/ ‘scratch (1.pl.)’	b.	/ʃɒp/+/ʃ/ ‘scratch (2.sg.)’
	/ʃnɒpː/		/ʃnɒpː/+/ət/ ‘catch (1.pl.)’		/ʃnɒpː/+/ʃ/ ‘catch (2.sg.)’

The corresponding structures to (127) are given in (128) for the singletons and in (129) for the geminates, respectively. Crucially, while the structures of (a) differ, the structures in (b) do not. We thus have three different representations: intervocalic geminates differ from word-final geminates in that only the former have a doubly-linked structure.

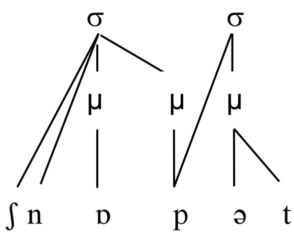
(128) a.



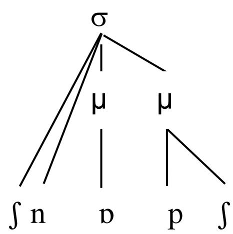
b.



(129) a.



b.



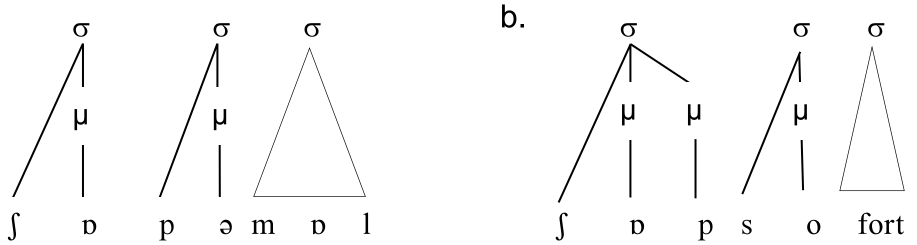
(129) reveals that inherently moraic consonants have two possible representations, depending on whether the consonant is realised heterosyllabically or in coda-only position. In the second case, (129)b), the structure coincides with the representation of non-moraic consonants that are assigned a structural mora, (128)b). It is in this context that we expect neutralisation. Our question of interest is whether heterosyllabic and coda-only moraic consonants are similar phonetically. Recall that Heusler and his successors reported intermediate sounds. This phonetic tripartite division is reflected in the structures depicted above: moraic consonants can be singly or doubly linked. Depending on the context, inherent moras are in allophonic distribution. In contrast, structural moras never exhibit a ‘flopping’ structure. After a short vowel in the coda, they coincide with inherent moraic consonants.

A third environment is created by postlexical syllabification. As laid out in 4.4, syllabification in ZG reapplies at the phrasal level. Extrametrical material is only permitted at the edge of a domain due to the Peripherality Condition. In 4.3.1, I proposed that the extrametricality rule only applies to word-final non-moraic obstruents. Once the word containing an extrametrical consonant is followed by another word, the extrametrical status is lost. (130) shows that the extrametrical consonant can be integrated in two ways: if a vowel-initial word follows, it is resyllabified into the following onset (a). Otherwise, it appears in the coda, where it is assigned a mora by WbP (b). If the consonant is a geminate, it remains entirely in its coda position when followed by an obstruent-initial word. Otherwise, it flops.

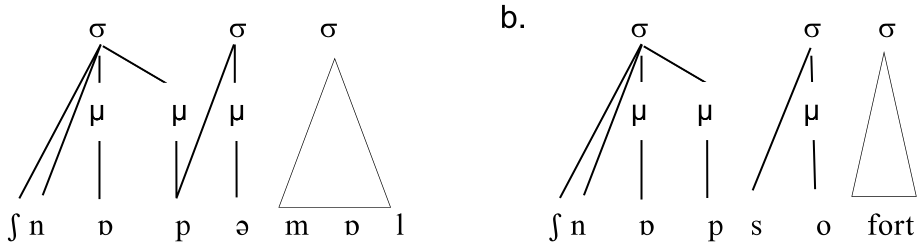
(130)	/ʃɒp/ ‘scratch’	a. /ʃɒp/+/əmɒːl/	b. /ʃɒp/+/sofortː/
	/ʃnɒpː/ ‘catch’	/ʃnɒpː/+/əmɒːl/’	/ʃnɒpː/+/sofortː/

The corresponding structures are given in (131):

(131) a. b.



(132) a. b.

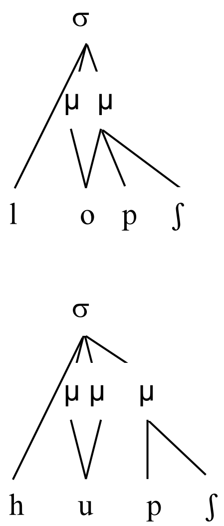


The representations above again show three different structures: Onset Maximization requires that word-final consonants are resyllabified in the following onsets whenever possible. Consequently, extrametrical singletons are resyllabified in the onset of the following word. Likewise, the heterosyllabic realisation of word-final geminates is imposed by Onset Maximization. When resyllabification fails to apply to the word-final consonant (due to sonority restrictions), it is singly linked to a mora. Singletons and geminates are neutralised in this position.

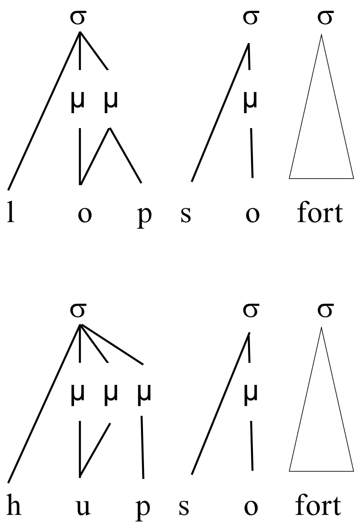
Note that the same principle also holds for Winteler’s Law: Winteler’s Law states lengthening for exactly those environments where WbP applies. Thus, the lengthening of coda sonorants follows the same mechanism as the neutralisation of coda obstruents. X-Theory is unable to account for these two processes in a unified fashion.

However, I have to conclude this section with a caveat. An open question is whether neutralisation also occurs after long vowels or bipositional rhymes in general. There appears to be no consensus as to whether all coda consonants are affected by WbP, or whether the application of WbP is limited to the consonant that immediately follows a single short vowel.[208] The representations below for the verb stems /loːp/ 'praise' and /huːpː/ 'honk' are again followed by either the inflectional suffix -*ʃ* or an obstruent-initial word. In (133), WbP is limited to the consonant immediately preceded by a short vowel. Any further consonant is integrated into the syllable via mora adjunction. In (134), on the other hand, WbP applies to all coda consonants (indicated by the bold line). The examples in (a) illustrate the lexical level, while (b) refers to the postlexical level.

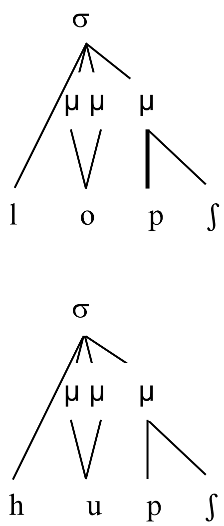
(133) a.



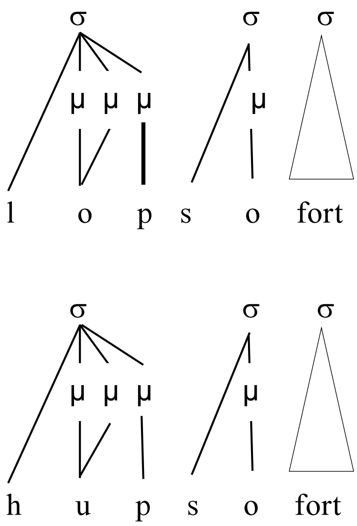
b.



(134) a.



b.



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[208] Kager (1999: 271) mentions "non-minimal violation of WEIGHT-BY-POSITION" thus suggesting that any coda consonant is subject to WbP. In light of WbP as a markedness constraint that ensures that codas make syllables heavy, it would be somewhat surprising if WbP applied to every coda consonant. If, however, any coda consonant is subject to WbP in ZG, neutralisation applies irrespective of the make-up of the preceding rhyme.

The representations differ in that singletons and geminates in (133) have the same structure only after short vowels. On the assumption that WbP applies to all coda consonants, (134), the contrast is neutralised after long vowels, too.[209]

5.2.4.2. Weightless geminates?

Kraehenmann's second argument against an analysis in Moraic Theory concerns the behaviour of geminates in stress placement. Crucially, Moraic Theory predicts that syllables closed by geminates count as heavy in a quantity-sensitive language. Kraehenmann argues that geminates in Thurgovian do not contribute to syllable weight. She (2003: 169) thus concludes that a "purely moraic account of the geminate consonants is inadequate".

Kraehenmann's objections are reminiscent of those of Tranel (1991), which I set out in 4.2.1.1. Her analysis is as follows (cf. Kraehenmann 2003: 178, 217). Thurgovian is weight-sensitive, and non-final syllables count as heavy only if the nucleus is branching. Sonorant consonants are syllabified in the nucleus, and obstruents are syllabified in the coda. Final syllables are heavy when either the nucleus or the coda branches. Final consonants are extrametrical. Thurgovian parses moraic trochees from left to right. Stress falls on the rightmost foot. The following examples are taken from her corpus.[210]

(135)	a.	ˈpi.ʃa.ma	'pyjamas'
	b.	a.ˈʀoː.ma	'aroma'
	c.	fla.ˈmiŋ.go	'flamingo'
	d.	me.lo.ˈdiː	'melody'
	e	ti.a.ˈlɛk͡xt	'dialect'

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209 Another possible locus for neutralisation is at the end of a phrase. It is well-known that languages tend to strengthen domain-final elements (Fougeron & Keating 1997). Previous studies on SwG have confirmed that word-final singletons lengthen in this position (Kraehenmann 2003 for stops and fricatives in Thurgovian; Schmid 2008 for fricatives in ZG). Furthermore, there are some indications (e.g. Dieth & Brunner 1943; Schmid 2008; Ehrenhofer et al. 2017) that the singleton/geminate contrast is least clear at word edges. Especially for coda consonants, the intuitions are blurred. Thus, moraic consonants that are not realised heterosyllabically are harder to distinguish from non-moraic consonants. Since phrase-final singletons are lengthened, the contrast is (almost) suspended. Blevins (2004, 2008) lists boundary lengthening as a possible pathway for the development of geminates.

210 To simplify matters, I will concentrate on trisyllabic words and dispense with words with schwa syllables. As for the latter, suffice it to say that Kraehenmann (2003: 185) introduces an additional parameter – Right Edge Marking, short: REM – that "scans for the first schwa … and constructs the right edge of a foot", thus forcing the preceding syllable to create a foot with the schwa syllable. As a result, pre-schwa syllables always receive stress, irrespective of their weight. The fact that pre-schwa syllables always receive stress also holds for ZG. I keep her transcription and represent geminates as double symbols.

(136) a. al.ˈpiː.no ‘albino’
b. em.ˈpaʀ.go ‘embargo’
c. aʀ.se.ˈnaːl ‘arsenal’
d. haʀ.mo.ˈniː ‘harmony’
e. int.teˈlɛk͡xt ‘intellect’

(137) a. the.ʀap.ˈpiː ‘therapy’
b. ˈk͡xa.nap.pe ‘sofa’
c. ˈma.ʀat.ton ‘marathon’
d. ˈal.pat.tʀos ‘albatross’

(138) a. ap.pet.ˈtitt ‘appetite’
b. k͡xomp.pʀo.ˈmiss ‘compromise’

The examples in (135) show that stress is on the rightmost heavy syllable. Heavy syllables either consist of a long vowel (b, d) or a vowel + sonorant cluster (c, e). If there are no heavy syllables, stress falls on the antepenult (a), which constitutes the head of the first syllabic trochee. Evidence for the end rule parameter setting is found in (136): although the initial syllable is heavy in all words, main stress is on the rightmost heavy syllable. The relevant examples are given in (137). Crucially, they all contain a geminate obstruent which should render the syllable bimoraic and thus heavy. In (137)a), stress regularly falls on the final (i.e. rightmost heavy) syllable. In (b–d), however, stress is invariably on the initial syllable, skipping the penult that is closed by a geminate. This suggests that syllables closed by geminates are light. In (138), stress is on the final syllable as predicted, since branching codas contribute to the weight of final syllables.

Since in Moraic Theory, geminates are moraic by definition, the Thurgovian stress pattern is problematic for Moraic Theory. However, the analysis does not hold for ZG. In the following, I will briefly present the main differences.[211]

[211] There are, to my knowledge, no publications on ZG stress patterns. The data I refer to are based on my own (unpublished) research on the subject, parts of which have been presented in Würth (2004a) and Würth (2004b). The grammaticality judgements are mine. A recent investigation is Stadler (2015). The data were collected during an exhibition and online via the application “Stimmen der Schweiz” [Voices of Switzerland]. Stadler found that foreign words are often stressed on the first syllable, with initial stress occurring much more frequently in the West of German-speaking Switzerland than in the East. The city of Zurich is approximately in the middle.

Like Thurgovian, ZG is quantity-sensitive, bimoraic feet are stressed. Contrary to Thurgovian, however, coda consonants are moraic in all word positions.[212] The data are rather scarce. The words are all of foreign origin and quite infrequent, cf. (139).

(139) a. ɒ.ˈlɒs.k͡xɒ ‘Alaska’
hiˈ.pis.k͡xus ‘hibiscus’
k͡xɒ.ˈlip.so ‘calypso’
b. tim.ˈpuk͡x.tu ‘Timbuktu’
kxɒm.ˈt͡ʃɒt.k͡xɒ ‘Kamchatka’

Under the assumption that word-medial obstruents do not contribute to syllable weight, Kraehenmann’s parameter settings predict that stress falls on the initial syllable, where it constructs a foot with the following syllable (as in (135)) or is bimoraic already. However, the initial syllable does not receive stress, even if it is heavy (b). Rather, penultimate stress in (139) indicates that the coda obstruent contributes to the syllable weight.[213]

Let us now turn to the weight contribution of obstruent geminates. Kraehenmann’s (2003: 203) data contain words that also occur in ZG. However, ZG stress placement seems to be less straightforward. Compare the Thurgovian examples in (140)a) with the corresponding items in ZG (b):[214]

(140) a. ˈk͡xa.nap.pe b. ˈk͡xɒ.nɒp.ˌpeː ‘sofa’
ˈne.kat.tif ˈne.kɒt.ˌtiːf ‘negative’
ˈma.ʀat.ton ˈmɒ.rɒt.ˌtoːn ‘marathon’
ˈmo.nit.toʀ ˈmo.nit.ˌtoːr ‘monitor’
ˈk͡xo.mit.te ˈk͡xo.mit.ˌteː ‘committee’

Kraehenmann argues that Thurgovian geminates are weightless since otherwise stress would fall on the penultimate in the examples in (140). In ZG, however, the final syllable contains a long vowel and is thus supposed to get primary stress under Kraehenmann’s analysis.[215] This reveals a recurring pattern in ZG that stress is often

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212 Kraehenmann (2003: 169) writes that “coda consonants do not add to the weight of the syllable”, yet she is not particularly explicit on the subject. Her claim is rather stipulative since she does not present any data in support of her assumption. The crucial data would be words of minimally three syllables where the penult is closed by a singleton obstruent while the ultima is light. Kraehenmann (2003: 177) notes that she could not “find a single example” of that kind.

213 Under the assumption that the medial syllable is light in the examples in (139) above, the syllable pattern is HLL in (a). The two light syllables can therefore construct a trochaic foot that would – by virtue of end rule: right – render the penult stressed. However, this option is ruled out by Kraehenmann’s (2003: 182) rule of stress clash resolution. In HLL words, main stress shifts from the left branch of the second foot to the first foot in order to avoid stress clash.

214 Kraehenmann (2003: 203) provides further data – *Karussel* ‘merry-go-round’ and *Mokassin* ‘moccasin’ – which I will not discuss here, since it is unclear if they contain a geminate consonant at all. A third example, *hopsassa,* is excluded as it is not an actual content word but rather an interjection in ZG.

215 Note that the ultimate gets secondary stress in ZG.

placed on the initial syllable, regardless of its weight.[216] The pattern also holds for ZG disyllabic LH words. In (141), stress is either on the final (a) – as predicted by Kraehenmann's stress rules –, or on the initial syllable (b).

(141)	a.	fɒ.ˈsɒːn	'pheasant'	b.	ˈsɒ.ˌloːn	'parlour'
		plɒ.ˈmɒːʃ	'disgrace'		ˈkɒ.ˌrɒːʃ	'garage'
		ɒ.ˈkæn:t	'agent'		ˈvi.ˌsent:	'wisent'
		fɒ.ˈkot:	'bassoon'		ˈmɒ.ˌmut:	'mammoth'
		k͡xo.ˈlos:	'colossus'		ˈkir.ˌɒf:	'giraffe'[217]

(142) shows disyllabic words of the structure HH. Again, stress can fall on the final syllable (a) – as predicted by the end rule right setting – or on the initial syllable (b).[218]

(142)	a.	pɛr.ˈsoːn	'person'	b.	ˈpɒl.ˌk͡xoːn	'balcony'[219]
		pɒn.ˈtit:	'bandit'		ˈk͡xɒmp.ˌpus:	'campus'

Initial stress in ZG occurs too often to be written off as an exception. The same holds for trisyllabic words, as shown in (140). The frequency of such forms suggests that stress placement on initial syllables is independent of weight. The examples in (143) show that light initial syllables get stress, even if the ultimate (a) or the penult (b) or both (c) are heavy.[220]

(143)	a.	ˈlɒ.prɒ.ˌtoːr	'Labrador'
		ˈjɒ.ku.ˌɒːr	'jaguar'
	b.	ˈpːe.ˌnɒlt.ti	'penalty'
	c.	ˈvɒ.lent.ˌtiːn	'Valentin (first name)'
		ˈki.prɒlt.ˌtɒːr	'Gibraltar'[221]

Turning now to words containing a geminate, we get a similar picture. Again, they often have initial stress, as seen in (140), repeated here as (144)a). However, words, where the stressed penultimate syllable is closed by a geminate, do occur (b).

216 Kraehenmann (2003: 188ff.) mentions similar examples for Thurgovian which she considers exceptions.

217 Kraehenmann (2003: 195) has [ˈkirɒf], where the final consonant is a singleton.

218 To mark the heterosyllabic nature of medial geminates, they are represented as double characters here.

219 Kraehenmann (2003: 197) has [ˈpalk͡xon].

220 Words like (143)b) are very rare, however.

221 Alternatively, we also find [ki.ˈprɒlt.ˌtɒːr].

(144) a. ˈk͡xɒ.nɒp.ˌpeː ‘sofa’
ˈmɒ.rɒt.ˌtoːn ‘marathon’
b. lɒ.ˈmet.tɒ ‘tinsel’
li.ˈbret.to ‘libretto’
ʃpɒ.ˈket.ti ‘spaghetti’
pːro.ˈsek.ko ‘sparkling wine’
ʋɒ.ˈlut.tɒ ‘value date’

Kraehenmann (2003: 207) considers penultimate stress in (144)b) “irregular”. Since all of her examples are “terms from the Italian cuisine”, she assumes that they can be grouped together as a subset. However, the instances are neither exclusively Italian nor semantically restricted to food.

In disyllabic words exhibiting a medial geminate, the stress placement varies, too (145).

(145) a. nɒt.ˈtuːr ‘nature’ b. ˈnɒt.ˌtyːr ‘plain (adj.)’
pɒp.ˈpiːr ‘paper’ ˈtːrot.ˌtʊɒːr ‘pavement’
fɒt.ˈtɒːl ‘fatal’ ˈlik.ˌkœːr ‘liqueur’[222]

The above examples provide little evidence to reject the claim that ZG geminates are moraic. While it is true that word-medial syllables closed by an obstruent geminate do not receive stress, this cannot be taken as evidence for the weightlessness of the geminates. Initial syllables are stressed for independent reasons.[223]

In sum, initial stress is always an option in ZG. It is lexical and independent of syllable weight or foot structure. Stress on the penultimate or the ultimate syllable, on the other hand, is rhythmic and sensitive to foot structure. Stressed penultimate syllables are either heavy or construct a foot with the ultimate. Stressed final syllables are always heavy.

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222 It probably has not escaped the attentive reader that the examples exhibiting “exceptional” initial stress are often of French origin. Indeed, Swiss German dialects are notorious for stressing French words on the first syllable (cf. numerous examples in Weber 1948: 51f.). As the majority of the words presented here are loans, a language-specific bias is likely. Schindler (1994) has shown that speakers make use of their mental concepts about a word and assign stress by analogy: A nonsense word such as *Calpain* may be associated with *Bahˈrain* taking its disyllabic stress pattern. If it is related to a medical term such as *Aspiˈrin* speakers stress *Calpaˈin*. Fleischer & Schmid (2006: 250) note a general “preference for word-initial stress in loans”. Compared to other loanwords, French loans are relatively old and well-established in colloquial speech (Weber 1948: 51f.). Contrary to more recent – and more sophisticated – loans, they might reflect ZG stress patterns quite solidly.

223 I assume that the syllable is lexically marked for stress in the sense of van der Hulst (1996; 1997; 1999; 2009; 2010). Van der Hulst assumes that the locus of primary accent is not established by rhythmical patterns. Rather, it is assigned to “special syllables” that are on the left- or rightmost edge of a word. According to van der Hulst (1997: 109), they can be special in that they are either heavy or diacritically marked (he mentions a third case, where lexical stress is established via foot structure, however, he expresses his doubts of whether primary stress is ever assigned rhythmically). Dresher & Lahiri (1991) point out the prevalence of initial stress in the history of Germanic. In their analysis of the Germanic foot, which has strictly initial primary accent, they (1991: 261) claim that syllables that follow a light initial syllable have no secondary stress “demonstrating again that a syllable following a light initial syllable is not treated as the head of a foot, even if it is heavy.” They suggest that such heavy syllables are incorporated into the foot of the preceding syllable.

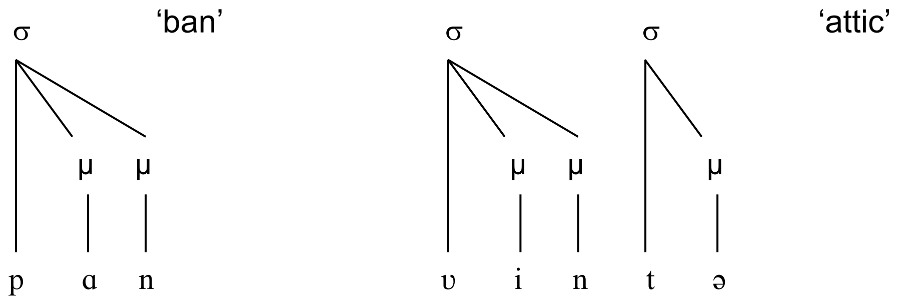
An in-depth analysis of the stress patterns in ZG would certainly be beyond the scope of the present thesis. Given the data just presented, however, it seems questionable whether Kraehenmann's analysis for Thurgovian can be adopted for ZG since stress placement in ZG can only partly be deduced from metrical stress rules. For many words, we have to assume lexical stress on the initial syllable. Thus, stress assignment provides little evidence to reject moraic geminates. Rather, the data presented add to the argument that ZG geminates are moraic. They count as heavy in stress assignment when their weight is not overwritten by lexical stress.

5.2.4.2.1. Winteler's Law

Further evidence for an analysis in terms of Moraic Theory comes from Winteler's Law, cf. 2.4.4. According to Winteler's Law the sonorants in (146)a) are "fortified" in coda position. If the phonetic correlate is duration, we expect that they are of longer duration than those in (b):[224]

(146) a. [ʋin·tə] 'attic' [pːlom·pə] 'filling' [mul·tə] 'hollow'
b. [ʃinə] 'rail' [nɒmə] 'name' [xilə] 'church'

If we compare the first syllable of the words in (146)a) to the words with word-final sonorant after the short vowel, cf. (147), they have exactly the same structure. In both cases the sonorant is moraic. The segments associated with mora are all phonetically interpreted the same, regardless of whether the moras are lexical or structurally assigned: a segment associated with a mora is always phonetically longer than a non-moraic segment. This explains why both the word-final sonorants as well as the word-medial sonorants in coda position are of longer duration:

(147)


[224] For clarity, the length of the sonorants is indicated here by the symbol [·]. As mentioned in fn. 85, Winteler uses double consonants, e.g. *vinnde.* I take the diacritic for the half-length because I suspect a length difference between moraic coda consonants and doubly linked geminates, duration being longer in the latter than in the former.

Further evidence for the moraicity of the sonorants in (147) comes from metrical phonology, where restrictions on minimal word size as well as stress assignment clearly indicate that sonorants in coda position contribute to syllable weight.[225]

5.2.5. Summary

In this chapter, I have discussed various approaches to neutralisation. It turned out that Heusler's Law represents a kind of neutralisation that was not in the focus of mainstream phonological theory. There are two reasons for this. First, the neutralised sound is not identical to one of the two opposition members. Therefore, it does not contribute to the arguments that were central to markedness theory. Instead, the neutralised sound is of a third – intermediate – kind, as described by Trubetzkoy as type 1. Second, the neutralised contrast is a suprasegmental singleton/geminate contrast. Both X-Theory and Moraic Theory can explain the neutralisation of suprasegmental contrasts.

The discussion on neutralisation in X-Theory and Moraic Theory showed that they make very different predictions. In X-Theory, neutralisation is accounted for by positing templatic restrictions on the syllable and deleting stray X positions. As I have shown for Kraehenmann's analysis on Thurgovian, neutralisation of a singleton/geminate is

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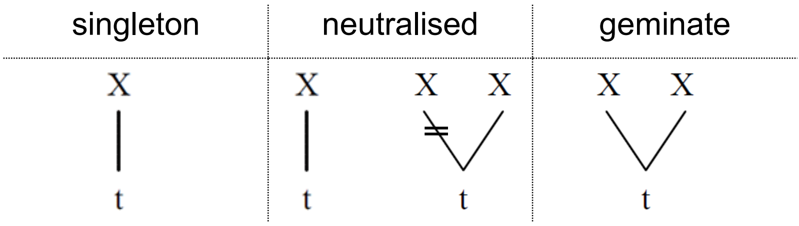
225 Kraehenmann (2003: 86) does not consider MSL a historical phonological process in its own right, her main argument being that it cannot fully account for the absence of paradigmatic length alternation between monosyllabic and disyllabic words when the stem ends in a sonorant (e.g. Thurgovian: t[aː]l – t[ɛː]ler 'valley, valleys', from MHG *tal,* cf. p. 82). Her line of reasoning is somewhat intricate and includes "a number of additional assumptions" (p. 88). Simplifying somewhat, she argues that the lengthening of the monosyllables should be analysed as levelling that took place after open syllable lengthening (OSL). This is essentially the standard explanation for StG (e.g. Paul 1884; Lahiri & Dresher 1999; see Seiler 2009 for counter-arguments). According to Kraehenmann, long vowels in words like t[ɛː]ler in present-day Thurgovian are relicts of a stage where OSL was productive. Her proposal, however, strikes me as somewhat stipulative. Apart from the long vowels in disyllabic words containing a sonorant, there is no evidence for open syllable lengthening in Thurgovian. Moreover, positing OSL for an earlier stage of Thurgovian – in Kraehenmann's terms: Middle Upper German – implies subsequent shortening of long vowels in disyllabic words with an obstruent, compare (hypothetical) Late Middle Upper German [klɛːsər] 'glasses' to Modern Thurgovian [klɛsər], cf. p. 91f.). As further evidence that OSL covered the entire Upper German area, Kraehenmann cites Grison, another High Alemannic dialect, which indeed has long vowels in disyllabic words containing an obstruent (e.g. [klɛːsər], p. 80), thus, Grison essentially looks the same as StG. To me, however, it is not quite clear where the data come from. Kraehenmann (2003: 79f.) mentions the dialect spoken in Chur and sketches its developments disregarding that Chur – as large areas of Grison in general – was Romance until the middle of the 14th century and the Rhaeto-Romance substrate is considered a crucial factor for the shaping of the German superstrate (see e.g. Ludwig 1989; Willi & Solèr 1990; Eckhardt 1991).

I have no concise alternative to offer, but I assume that all instances of lengthening in monosyllabic words are due to MSL. As has already been shown for CVC-shaped words that end in a singleton obstruent, MSL is a prosodic means to meet with minimality requirements. Such an analysis seems possible without detour via OSL. In the case of the sonorants, the resulting long vowels were subsequently stored as underlyingly long in the lexicon. Whether OSL is taken as a starting point with subsequent levelling of the monosyllables – as Kraehenmann suggests – or whether (as I suggest) we take MSL as the primary mechanism: either way, we have to assume that in the case of sonorants, the lengthened vowels became lexically long. The advantage of the present approach is that we can dispense with an intermediate stage of OSL that is not attested.

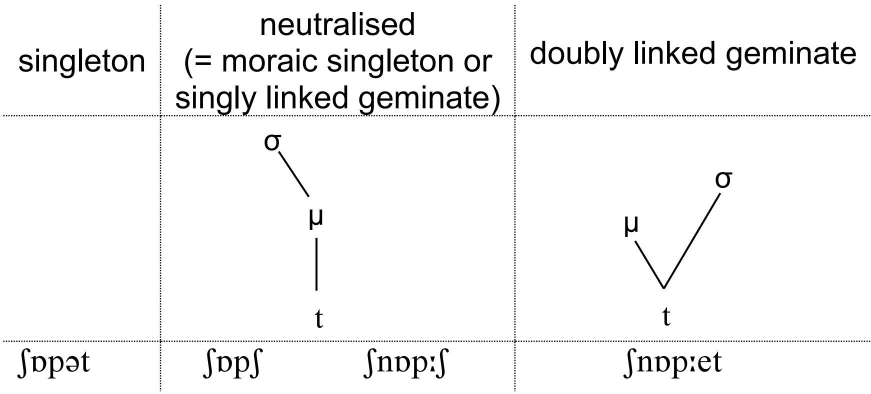
in effect lenition, and the neutralised sounds collapse with singletons. As schematised in (148), there is no “third kind”. Neutralisation in X-Theory ultimately leads to type 3 in Trubetzkoy’s typology.

(148) Neutralisation as stray erasure (Kraehenmann 2003):



In Moraic Theory, neutralisation is a consequence of the two circumstances in which consonants are moraic. According to Topintzi (2008: 173), “moras are allocated a minimum target duration, whose implementation in terms of timing takes precedence over any other segment-specific effects”.[226] We would, therefore, expect that neutralised singletons are longer than their non-neutralised counterparts. Dialect descriptions that assign a half-fortis value to the neutralised consonants seem to confirm this. If a phonological representation is to reflect the phonetic reality, Moraic Theory better represents this reality than X-Theory. To account for neutralisation, X-Theory must inevitably make a binary choice between one and two X positions. Moraic Theory, on the other hand, offers a third option. The three possible representations are given in (149):

(149) Positional neutralisation in Moraic Theory:



Geminate consonants are always moraic. However, they are only doubly linked if language-specific sonority requirements are met. If flopping is not possible, they are singly linked. The neutralised condition in (149) thus reflects both, a singly linked lexical mora as well as a singleton that is assigned a structural mora. Note that the third option cannot constitute a phoneme of its own. Both the singleton and the geminate have

226 On the relationship between moraicity and timing, see e.g. Hubbard (1994), Broselow et. al. (1995), and Ham (1998).

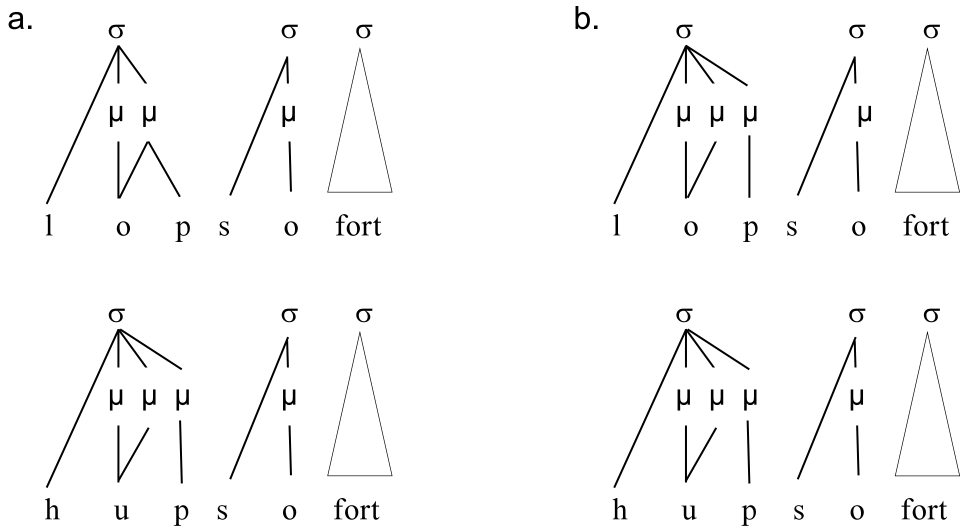
what we may call an “allophonic variant”: Singletons have a moraic variant under coercion and geminates have a doubly linked variant.

Further evidence for an analysis of ZG geminates as moraic comes from stress assignment. In this chapter, I presented additional evidence for the weight-bearing nature of geminates. Unlike Kraehenmann, I assume that geminates contribute to syllable weight. The counter-examples put forward by Kraehenmann all have initial stress in ZG. I have argued that the tendency to stress the initial syllable is independent of quantity in ZG.

The chapter once more concludes with two caveats. First, Moraic Theory can account for neutralisation only by referring to prosodic positions. This leaves open the question of how neutralisation works for onsets. If, as Heusler’s Law predicts, neutralisation also affects singleton onsets, they cannot be explained by Moraic Theory. This can be viewed as a possible disadvantage of Moraic Theory. It should be noted, however, that X-Theory is also unable to account for the fortition of onset singletons. In X-Theory, neutralised consonants are invariably short. This also holds true for neutralised coda consonants. The advantage of Moraic Theory is that – in the spirit of Trubetzkoy – it offers a representation for the “intermediate” sound. As I have shown in (149), the allophonic distribution of singleton, neutralised, and geminate coda consonants can be straightforwardly represented in Moraic Theory. The phonetic basis of the representations proposed here will be examined in the following chapter. If the representation assumed here is correct, we expect durational differences where the singleton (149)a) is shortest, and the doubly linked geminate (c) is longest. The representation in (b) is of intermediate duration.

Second, as I mentioned previously, I have left the question open whether WbP applies to all coda consonants or only to those that immediately follow a short vowel. Winteler’s Law is based on the latter assumption, but it has not been confirmed by the few empirical investigations available (Willi 1990; Seiler & Würth 2008). If moraicity is indeed reflected by duration, we would thus expect that consonants that tautosyllabically follow a short vowel and therefore are linked to a mora of their own are longer than those that are but adjoined to a mora. The structures presented earlier as (133) and (134) are partly repeated in (150) below.

(150)



In the first column, (a), the singleton differs from the geminate since it follows a long vowel and therefore has no mora of its own. In the second column (b), WbP applies to any coda consonant. Thus, the singleton labial stop obtains a structural mora which makes it indistinguishable from the inherently moraic geminate below.

I assume that lengthening under Winteler’s Law is subject to the same conditions as the neutralisation of the codas in Heusler’s Law. In both cases, therefore, I expect the same structures, either (a) or (b).

6. Phonetic measurements

As indicated previously, the *fortis/lenis* distinction in SwG dialects has been a matter of intense debate not least because a phonetic correlate turned out to be hard to find. Several studies have shown that the most salient correlate is duration, which would parallel the phonological status of *fortis* consonants as geminates. In his comprehensive study on intersonorant word-medial stops, Willi (1996) found that *fortis* and *lenis* differ only with regard to duration. Intensity, spectral structure, and VOT do not play a role in the differentiation of the two series. Willi (1996: 198) rebuts the claim initially made by Winteler that *fortis* consonants are articulated with greater articulatory force and concludes that it is unnecessary to posit an underlying contrast in terms of intensity.

This chapter is structured as follows. 6.1 gives an overview of the phonetic studies carried out since Dieth & Brunner (1943) began to investigate the topic empirically. As far as the SwG *fortis/lenis* distinction is concerned, the investigations focused almost exclusively on the distinction in contrastive position. Thus, only little is known about neutralisation phenomena. The present work intends to contribute to closing this gap.

In the remaining sections, my own investigation is presented. 6.2 describes the general methodology of the acoustic study. I start by laying out the central questions in 6.2.1. Information about the speakers is provided in 6.2.2. The word material is presented in 6.2.3. The general procedure of recording, segmentation and data analysis (including statistical analysis) follows in 6.2.4.

The results are presented in Section 6.3. The measurements for the stops (6.3.1), the fricatives (6.3.2) and the sonorants (6.3.4) are divided into three subsections. The obstruents are examined in both non-neutralised and neutralised environments. For the former, I expect the earlier findings to be confirmed. The focus of this investigation is on the behaviour of singleton and geminate consonants in neutralised position. Two questions are at the centre of this investigation. First, can the measurements confirm Heusler's impression that neutralisation leads to an "intermediate" sound? And second, are there any differences between the neutralised sounds, and if so, what conditions determine the distribution? The subsection on the sonorants follows the same structure, the main question being whether there is any confirmation for Winteler's Law.

The summaries in 6.3.3 and 6.3.5 revisit the data presented in the previous sections. They explore the initial question of whether neutralisation is indeed positional neutralisation. Remarks on outstanding questions conclude each section.

6.1. Previous studies

Early instrumental studies on the *fortis/lenis* opposition in Alemannic were conducted by Gassert (1929) on medial and final stops in the dialect of Constance, and Ketterer (1942) on initial and medial stops and fricatives in the area of Baden (Germany). They found voiced consonants in all positions. Ketterer measured that *fortis* stops are about twice as long as *lenis* stops. The earliest experimental investigation on the *fortis/lenis* contrast in Swiss dialects, including ZG, is Dieth & Brunner (1943). They set out to explore the claim made by Sievers (1901) that “real” geminates consist of two peaks. The data could not conclusively answer the matter as it revealed considerable variation among speakers and dialects. However, they found that *fortis* stops are about three times longer than lenis stops.[227] They also identified three factors that influence the duration: *Fortis* stops are longer when (1) preceded by short vowels, (2) they are medial (compared to initial stops) and (3) appear in a stressed syllable. In a later study, Brunner (1953) found occasional voicing of *lenis* stops which occurs, however, highly inconsistently across speakers. Brunner considers it phonemically irrelevant for ZG.

Referring to the work on VOT by Lisker & Abramson (1964), Enstrom & Spörri-Bütler (1981) examined the significance of VOT in ZG word-initial stops. They (1981: 138) found that the two series have almost identical VOT, concluding that “in Swiss-German VOT does not constitute the primary feature in differentiation between stop cognate pairs”. They suggest retaining *fortis/lenis* as a feature even though the corresponding articulatory property is unclear.

In his acoustic study on ZG stops, Fulop (1994), too, reports differences in closure duration and that VOT does not play any role in the distinction of the two series. Intervocalic *fortis* stops are approximately three times longer than *lenis* stops. Since CD is not perceptible in word-initial position, Fulop searches for secondary cues that help maintain the distinction. He finds that the formants of a vowel preceded by a *fortis*

[227] It is, as Kraehenmann (2003: 100) rightly points out, not entirely clear what Brunner & Dieth are referring to by “duration” as they do not specify whether the measured data excludes the VOT portion – i.e. includes only closure duration – or not.

stop are higher than when it follows a *lenis* stop. Fulop (1994: 116) claims that the so-called "spectral tilt" indicates higher articulatory intensity that "can be employed to preserve the fortis/lenis contrast". This conception of *fortis/lenis* stands in a long tradition (e.g. Kohler 1984) acting on the assumption that a phonological feature takes on several strategies to maintain a contrast. In Würth (2002: 51f.), however, I have expressed doubts whether the spectral tilt is relevant to serve as a secondary cue. The major drawback is that the *fortis/lenis* pairings that display spectral differences are no proper minimal pairs; in fact, the following vowel differs in either quality or in quantity: e.g. [piːkə] vs [pːikə] 'pile (inf.)' vs 'piled (p.p.)', [kynə] vs [kːunə] 'win (inf.)' vs 'won (p.p.)', [toːrfː] vs [tːœːrfː] 'village' vs 'may (3.sg.)'. When actual minimal pairs are concerned, as in e.g. [pɒːr] 'bar' vs [pːɒːr] 'pair' or [prɒːtə] 'roast (inf.)' vs [pːrɒːtə] 'roasted (p.p.)', Fulop (1994: 91) concedes that "the speaker did not make the fortis/lenis contrast."[228]

The most influential investigation on ZG is Willi (1996). He examined the duration of *fortis/lenis* word-medial stop pairs, finding that the *fortis* stops are on average 70% longer than their *lenis* counterparts.[229] Furthermore, he confirms Enstrom & Spörri-Bütler's (1981) findings that VOT is insignificant. In an additional perception test, he finds some indication that the ratio between the duration of the preceding vowel and the following consonants is a decisive factor in determining the category.

Ladd & Schmid (2018) investigated the F0 effects that usually accompany voiceless consonants. Voicing contrasts are known to affect the fundamental frequency of the following vowel. F0 is higher when preceded by a voiceless consonant and lower when it follows a voiced consonant. Building on earlier work by Hanson (2009), Ladd & Schmid (2018: 232) state that F0 is "locally raised after voiceless stops" while it remains unaltered after voiced stops. In their study on ZG F0 effects, however, they found a slight (but statistically non-significant) difference between *fortis* and *lenis* stops.

In her in-depth study on Thurgovian, Kraehenmann (2003) finds that *fortis* consonants are longer than *lenis*. The ratio between *fortis* and *lenis* consonants depends on the position within the word (where differences in duration are largest word-medially), and

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228 Closure duration undoubtedly is of paramount importance both acoustically and perceptually. For several languages, there is some evidence that the geminate/singleton contrast is enhanced by secondary cues, especially in utterance-initial position when CD cannot serve as an indicator (see e.g. Abramson 1986 on Pattani Malay; Ridouane 2007 on Tashlhiyt Berber).

229 Cf. Willi (1996: 195): "Die akustische Untersuchung hat gezeigt, dass die Fortis-Plosive […] nach Sonorlaut im Mittel um etwa 70% länger sind als ihre Lenis-Gegenstücke […]"

on the manner of articulation (with stops exhibiting the highest ratio). She found no correlation between the duration of the consonant and the duration of the preceding vowel. Kraehenmann's (2003: 118, 125; 145, 148) acoustic measurements for word-medial and phrase-medial obstruents are summarised below. (151) shows that word-medial geminate stops are approximately three times longer than singletons, while the ratio for the fricatives ranges between 1.7 and 2. (S = sonorant consonant; C = obstruent):

(151)

		no neutralisation		
	environment	S_V	VV_V	V_V
a.	singleton stop	43.8	60.1	58.5
	geminate stop	136.8	160.9	170.6
	ratio gem. : sing.	3.1	2.7	2.9
b.	singleton fricative	97.1	101.6	89.0
	geminate fricative	151.6	171.0	175.0
	ratio gem. : sing.	1.7	1.7	2.0

(152) shows the mean closure duration of word-final stops (a) and the mean segment duration of word-final fricatives (b) in a phrase-medial context in non-neutralising and neutralising environments. Compared to the word-medial instances above, the ratios for non-neutralised obstruents are lower in phrase-medial contexts. The contrast is neutralised, when the following word begins with an obstruent, i.e. _#C:

(152)

		no neutralisation				neutralisation	
	environment	S_#V	S_#S	VV_#V	VV_#S	S_#C	VV_#C
a.	singleton stop	49.2	69.3	54.8	63.5	69.0	74.5
	geminate stop	110	96.9	141.8	112.5	66.1	83.9
	ratio gem. : sing.	2.2	1.4	2.6	1.8	1	1.1
b.	singleton fricative	94.6	102.9	104.3	94.6	108	123.3
	geminate fricative	130.5	122	157	147.2	117.7	132
	ratio gem. : sing.	1.4	1.2	1.5	1.6	1.1	1.1

The ratios in the neutralised environment show that singletons and geminates have approximately the same duration. However, as mentioned previously, they do not coincide with the singleton value. With one exception (stops preceded by sonorant), neutralised singletons are longer than non-neutralised singletons.

In a perception test, Kraehenmann further investigated the listener's ability to distinguish utterance-initial *lenis* from *fortis* stops. She found that the informants were unable to recognise a difference, which suggests that closure duration is, in fact, the only acoustic cue available for the distinction. Kraehenmann & Jaeger (2003) showed in a pilot study using electropalatography (EPG), that the linguopalatal contact is longer for initial geminates than for singletons. In a follow-up study with four SwG speakers, Kraehenmann & Lahiri (2008: 4446) confirmed earlier findings on the irrelevance of VOT and the importance of CD. Their EPG measures furthermore demonstrated that speakers produce *fortis* stops "with substantially longer oral closure" than the *lenis* counterparts. Moreover, the linguopalatal contact is longest for utterance-initial geminates. This leads to the somewhat paradox situation that speakers articulate a contrast that goes unnoticed by listeners. Kraehenmann & Lahiri (2008: 4453) conclude that there is "no articulatory neutralisation of the word-initial quantity contrast". They further found that both, *fortis* and *lenis* word-initial stops are longer when articulated in isolation (i.e. post-pausally), which they (2008: 4451) attribute to "articulatory strengthening at the beginning of a higher prosodic domain".

To my knowledge, only few investigations explored Swiss German obstruents in neutralisation contexts. For Thurgovian, Kraehenmann (2003) and Kraehenmann & Jaeger (2003) did not find a significant durational difference between neutralised *fortis* and neutralised *lenis*. Kraehenmann & Lahiri (2008: 4452), on the other hand, report a statistically significant difference between neutralised *lenis* and *fortis.* However, since the difference is very small (16 ms), they raise legitimate doubts about the perceptibility of the contrast.

For ZG, Schmid (2008) investigated the duration of word-medial and word-final fricatives produced by three speakers. For word-medial fricatives, he found that lenis fricatives are approximately half as long as the *fortis*. Contrary to Bernese, however (cf. Ham 1989), he reports that preceding vowel length has virtually no influence on the duration of either the *fortis* or the *lenis* fricative. Phrase-finally, both *fortis* and *lenis* fricatives are longer than their word-medial counterparts. In the case of the *fortis,* the length of the preceding vowel does not affect the duration. Word-final *fortis* and *lenis* fricatives have virtually the same duration when followed by an obstruent-initial word. The neutralised fricatives have almost the same duration regardless of the length of the preceding vowel.

Only little is known about SwG sonorants. Kraehenmann (2003) assumes an underlying singleton/geminate contrast for Thurgovian in word-medial position. Her measurements show that the durational difference is significant; word-medial geminates are almost twice as long as singletons. Word-finally, singletons occur after short vowels and geminates occur after long vowels. The mean difference is 20 ms prepausally and approximately 40 ms in medial position. When singletons occur in coda position phrase-medially, they are on average about 14 ms shorter than geminates. In her study, all singletons occur after long vowels and all geminates are preceded by a short vowel, therefore, no direct comparison is possible, and no statistical conclusions can be drawn. Furthermore, Kraehenmann's corpus does not contain any instances of word-medial sonorants (such as ʋɒlt 'forest') which would fit the structural description of Winteler's Law. Like ZG, Thurgovian word-final sonorants are short after long vowels, and vice versa. Her results show that after long vowels, word-final sonorants somewhat shorter than after short vowels, cf. (153):

(153) duration (in ms) of word-final sonorants within phrase (Kraehenmann 2003: 162)

	singleton			geminate		
environment	VV_#C	VV_#S	VV_#V	V_#C	V_#S	V_#V
	94.5	99.4	90.4	108.1	110.0	132.0

(153) reveals that the geminate followed by a vowel sticks out. This can be taken as evidence for their geminate status. If they were only positionally long, we would expect them to be resyllabified entirely in the following onset.[230]

To my knowledge, the only experimental study on Winteler's Law is Willi (1990). Willi analysed the duration of the coronal nasal in various positions. The data material was gained from spontaneous speech of three male dialect speakers (one of them spoke ZG). Willi found that the duration of the sonorants under Winteler's Law is about 14% longer than in all other environments. However, the results show a considerable amount of variability. Based on these findings, Willi (1990: 571) regards the assumption as refuted that "in the position demanded by Winteler's Law, *all* manifestations of [n] have a longer duration than in the other possible positions."[231]

230 It may be worth noting that Kraehenmann's examples are all adjectives. As stated in 2.3.2.1, adjectives seem somewhat idiosyncratic in this respect. I assume that the final sonorant of monosyllabic adjectives containing a short vowel is inherently moraic. As a result, it has a flopping structure in the intervocalic context.

231 [Orig.: "Damit ist zumindest die Annahme widerlegt, dass in der von Winteler's Gesetz geforderten Position *sämtliche* Manifestationen von [n] grundsätzlich grössere Dauer als in den übrigen möglichen Positionen hätten."]

In an unpublished pilot study, Seiler & Würth (2008) measured the absolute durations of sonorants and obstruents in alternating verb forms of six different verbs. Three native speakers of ZG were given the infinitive of the verb in StG. Their task was to embed the correct form in simple ZG matrix sentences. The sample included sonorants, singleton obstruents and geminate obstruents, each after short and after long vowel. We found that sonorants and singleton obstruents lengthen in coda position, irrespective of the length of the preceding vowel. The mean ratio of durations in coda vs intervocalic positions is given in (154):

(154)

environment	V_	Vː_
Coda	e.g. /fylʃ/ 'fill (2.sg.)'	e.g. /fyːlʃ/ 'feel (2.sg)'
Onset	e.g. /fylə/ 'fill (inf.)'	e.g. /fyːlə/ 'feel (inf.)'
ratio Coda : Onset	1.9	1.6

Our measurements revealed a tendency of coda sonorants (and singleton obstruents) toward the duration of geminates, which we took as an indication that coda consonants are moraic.[232]

A somewhat different path is taken in a perception test conducted by Ehrenhofer et al. (2017). They investigate how the singleton/geminate distinction is stored in the mental lexicon. More specifically, their experiments are designed to find out whether and how the singleton/geminate difference is underspecified. Previous work on Bengali (Lahiri & Marslen-Wilson 1992; Kotzor et al. 2017) has suggested an asymmetry in favour of the singleton. In the experiment, the consonant duration was manipulated such that words containing a geminate had a singleton (e.g. the non-word sʊpə instead of sʊpːə 'soup'), and vice versa. Participants were presented these words auditorily, and they were instructed to react to a visual input of a semantically related word. The reaction time was measured, the chief assumption being that lexical access is facilitated when the word given – *Bouillon,* 'broth' in the above case (cf. Ehrenhofer et al. 2017: 213) – is primed by a semantically related word. If participants were able to connect *Bouillon* to (forged) sʊpə, a shorter recognition time was expected, which "indicates that the acoustic input has been successfully mapped onto the underlying representation. Where recognition is inhibited, this suggests that the manipulation of medial consonant duration led to a failure in this mapping." The results suggest that geminates and singletons are asymmetrically processed: the informants were able to identify

232 These measurements suggest that all coda consonants are affected by WbP. It should be noted, however, that the statements refer to a single verb per manner of articulation and rhymal environment.

singletons manipulated to geminates as singletons, but not vice versa. In a Featurally Underspecified Lexicon (FUL) model (e.g. Lahiri & Reetz 2010) an underspecified feature can be mapped onto any acoustic input (so-called NO-MISMATCH). Underlyingly specified features, on the other hand, have to agree with the actual acoustic input (MATCH). If they fail to do so, the data cannot be interpreted (MISMATCH). Ehrenhofer et al. (2017: 223) argue that SwG singletons are underspecified, such that "only acoustic information that meets the criteria for geminate recognition can be mapped onto an underlying geminate, whereas consonant information of any duration can be mapped onto an underlying singleton." The question concerning underspecification is related to the issue of whether the representation is binary or privative. If the singleton/geminate opposition is binary, this would be evidence for a skeletal representation (i.e., one vs two X-slots). A privative opposition, on the other hand, would be in favour of moraic models (i.e. presence vs absence of a mora). For Bengali, Kotzor et al. (2017) propose that duration is privative. The asymmetric findings in SwG point in the same direction (Ehrenhofer et al. 2017: 224).

6.2. Method

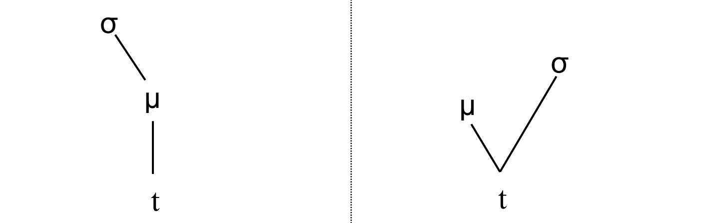
The main aim of the phonetic study is to investigate the durational contrasts for stops, and fricatives, in neutralised and non-neutralised condition. The central research question is whether neutralised consonants are indeed phonetically 'half-fortis' and which (if any) factors influence the duration. In order to establish a base of comparison, the duration for non-neutralised singleton and geminate consonants is also measured using the same factors. The second purpose of this investigation is to shed light on the durational differences of sonorant consonants proposed in Winteler's Law. I expect the phonetic analysis of Winteler's Law to provide additional insight into the moraicity of the coda consonants.

6.2.1. Research questions

The central research questions are listed below. They are divided into questions about non-neutralised data and neutralised data. The overriding question is whether Heusler's Law and Winteler's Law can be confirmed empirically, which should yield three distinct durations.

Recall from the previous chapter, that Moraic Theory offers three representations for these outputs, cf. (149), repeated as (155) below.

(155) Positional neutralisation in Moraic Theory:

singleton	neutralised (= moraic singleton or singly linked geminate)	doubly linked geminate
		
ʃɒpət	ʃɒpʃ ʃnɒpːʃ	ʃnɒpːet

From (155) it follows that in neutralised position singletons and geminates are structurally equal. We thus expect it to be reflected phonetically as similar durations.

An undecided matter concerns the application of WbP. If WbP affects only consonants that directly follow a short vowel, it can be expected that neutralisation only occurs in this environment. Put succinctly, the labial stops in ʃɒpʃ – ʃnɒpːʃ are the same, whereas in loːpʃ – huːpːʃ they are not, cf. (133). If WbP affects all coda consonants, we expect neutralisation in any coda position, cf. (134).

Basic questions for the analysis of the obstruents

Can Heusler's Law be confirmed? Put more concretely, is the duration of obstruents in an intersonorant context different from the duration in a neutralised context?

(1) Category (non-neutralised)

Are there significant differences in closure duration for intersonorant singletons and geminates?

With regard to the obstruents, this question has already been answered in the affirmative in earlier work (see 6.1, above). Thus, I expect the results to confirm earlier findings.

VOT is additionally measured for the stops. Earlier research has found no significant differences in VOT between singletons and geminates. Again, it is expected that the results corroborate these findings.

(1.1.) Syllabification across word boundaries

Do the duration differences between singletons and geminates also hold across word boundaries?

Under the assumption that Swiss German dialects syllabify across word boundaries (Moulton 1986; Kraehenmann 2003; Fleischer & Schmid 2006), we do not expect differences between word-medial and phrase-medial data. However, several experimental studies have pointed out that geminates which “flop” across the word boundary are shorter than word-medially.[233]

(1.1.1) Position in the word: initial vs final (stops only)

Does the position in the word affect the duration of singletons and geminates?

This additional factor is relevant for phrase-medial contexts only. Since phrase-medially, singletons are always in the onset and geminates always have a heterosyllabic structure, no differences are to be expected. However, for Thurgovian, Kraehenmann (2003: 133) measures significantly shorter CDs for word-initial stops. Dieth & Brunner (1943: 745) also report that word-initial geminates are shorter than medially.

(1.2.) Influence of the rhyme structure

Does the structure of the preceding rhyme influence the duration of singletons and geminates?

Several investigations have shown that geminates are shorter after long vowels than after short vowels. For ZG, however, the difference is reportedly rather small. It will be investigated here whether the preceding rhyme has an influence on the following consonants and whether it affects both singletons and geminates.

[233] Payne (2005) reports for Italian, that postlexical geminates are shorter than lexical geminates. However, the postlexical geminates in Italian are derived geminates (via *raddoppiamento sintattico).* Postlexical geminates in ZG, on the other hand, are inherently moraic consonants that meet the structural description that allows them to ‘flop’. It is therefore reasonable to expect no difference between lexical and postlexical geminates. See also Ladd & Scobbie (2003).

(2) Category (neutralised)

How are singletons and geminates affected by Heusler's Law?

Two main questions are in focus here. On the one hand, we want to investigate how the duration of neutralised consonants manifests itself in the two categories. On the other hand, the question is whether Heusler's Law affects all consonants, regardless of the combination of the categories (see Fleischer & Schmid 2006: 248).

2.1. Syllabification across word boundaries

Does Heusler's Law also apply across word boundaries?

Acting on the assumption that Heusler's Law also applies across words (see Section 2.4.3), we do not expect any differences.

2.1.1 Position in the word: initial vs final (stops only)

Does the position in the word affect the duration of neutralised consonants?

To my knowledge, there are hardly any studies on neutralised word-initial stops. Kraehenmann (2003: 130) reports neutralisation. Heusler's Law does not predict any differences, either.

2.2. Influence of the rhyme structure

Does the structure of the preceding rhyme influence the duration of the neutralised consonants?

This question aims to determine whether structural differences are reflected in the measurements, in particular, whether Weight-by-Position applies to all coda consonants or only to those that directly follow a short vowel. If WbP only affects singletons after short vowels, singletons and geminates are expected to differ after long vowels.

If WbP affects all coda consonants, singletons and geminates are structurally indistinguishable whenever they are in the coda. Accordingly, we would expect them to have the same duration.

Basic questions for the analysis of the sonorant consonants

Are coda sonorants longer than onset sonorants? In particular, does the duration of the preceding vowel influence the duration of the coda sonorant, i.e. can Winteler's Law be confirmed?

In 2.3.2.1, I have raised the question of whether ZG has sonorant geminates. Kraehenmann (2003: 41) assumes an underlying contrast for Thurgovian, which is also confirmed by her measurements. Referring to older grammars, I have shown that geminates in ZG must be a recent development. Aside from the adjective forms, there is no evidence for word-medial geminates. The present study is therefore limited to onset sonorants and tautosyllabic coda sonorants. For phrase-medial contexts, however, I assume that word-final sonorants are resyllabified in the onset of the following word, provided it begins with a vowel. If this assumption is confirmed, it would indicate that word-final sonorants are underlyingly non-moraic.

Winteler's Law predicts neutralisation only after short vowels. Since Winteler's Law is a consequence of WbP, the measurement results could give additional indication of how mora assignment in the coda works.

6.2.2. Speakers

For the recordings, eight (5 female and 3 male) native speakers of ZG were selected. As outlined in 1.3, all speakers use dialect in everyday oral communication. They also have command of the standard language, which is predominant in written form. The main selection criterion was that they were born and raised in the ZG speaking area. They are all personal acquaintances, and I judged them as representative ZG speakers. To get a broader picture, they were asked about their linguistic background. Table 11 below gives an overview. None of the participants was linguistically trained, and they were unable to guess the topic of the investigation.[234]

[234] The subjects' linguistic naivety sometimes had a detrimental effect on the execution of the task: They were all asked to utter the sentences as if they were used in conversation. However, some of the informants initially misinterpreted the task and instead tried to pronounce the target words with utmost diligence and in an isolated fashion. To a certain extent, this shortcoming could be compensated for by the speakers having to repeat all sentences. Usually the second recording was more natural, which is why it was used for the analysis, cf. 6.2.4, below.

speaker	sex	year of birth	Current place of residence	Childhood place of residence	Do/Did your parents speak ZG? (Y/N)	Does your social environment mostly speak ZG? (Y/N)	Have you ever lived in a dialect area other than Zurich?[235]
01	f	1967	City of Zurich	Amt (Canton of Zurich)	Y	Partner: Y Friends: Y	N
02	m	1953	City of Zurich	City of Zurich	Mother: N Father: Y	Partner: N Friends: mixed	N
03	f	1960	Amt (Canton of Zurich)	Amt (Canton of Zurich)	N	Partner: Y Friends: mixed	Y (4 years in the Canton of Argovia)
04	m	1974	City of Zurich	City of Zurich	N	mixed	N
05	f	1945	Amt (Canton of Zurich)	City of Zurich	Mother: Y Father: N	Partner: N Friends: Y	N
06	f	1964	City of Zurich	City of Zurich	Y	mixed	N
07	f	1960	Schaffhausen	Lake of Zurich	N	Partner: N Friends: mixed	Y (Thurgovia, Schaffhausen)
08	m	1947	City of Zurich	City of Zurich	N	mixed	N

Table 11: Linguistic background of the informants

Table 11 reveals that younger speakers are underrepresented. This may lead to the description of a more conservative variety of ZG. Indeed, the variety of younger speakers seem to differ in several aspects (see, e.g. Landolt 2010).

6.2.3. Corpus

The data are part of a broader corpus that consists of a total of 361 items. The corpus was designed for future research and tests the target items in up to 5 environments, including phrase-initial and phrase-final contexts; also, it contains recordings of additional consonants. For the obstruents, the data set is restricted to labial stops and fricatives. The decision was made for two reasons. First, coronals regularly undergo regressive place assimilation (cf. 2.4) that would distort the results. Second, the velar (and palato-alveolar) fricatives have no clear contrastive status (cf. 2.3.1).

Of the 361 items, 231 sentences are used for the present study. The data analysis is restricted to labial obstruents (for Heusler's Law) and to /m/, /n/, and /l/ (for Winteler's

[235] The answers do not imply that the informants never trespassed the border of the Canton of Zurich. Some of the speakers spent some years abroad or in the French speaking part of Switzerland. Since I expect inferences only when in contact with other Swiss German dialects, such information is not included here.

Law). All the consonants at issue occur in a (phrase-)medial context. Table 12 gives an overview. Sonorant consonants are not shown as geminate/singleton pairs here. As noted in 2.3.2.1, they are in complementary distribution. Adjectival forms, as well as words ending in *-ər,* are not considered in the following analysis.

speaker	01	02	03	04	05	06	07	08	total
stops	91	89	91	91	93	93	92	91	731
p	48	47	48	47	49	49	48	47	383
pː	43	42	43	44	44	44	44	44	348
fricatives	55	57	56	58	56	58	57	58	455
f	22	25	25	25	25	25	24	25	196
fː	33	32	31	33	31	33	33	33	259
sonorants	91	96	97	96	102	101	100	97	780
l	41	43	43	43	44	44	43	42	343
m	27	28	27	28	31	30	31	29	231
n	23	25	27	25	27	27	26	26	206

Table 12: Overview of the data[236]

6.2.4. Recordings and data analysis

The data were collected using *BAS SpeechRecorder* (Draxler & Jänsch 2004). The recordings were usually made at the informants’ place and twice in my flat. I recorded the speakers with a Samsung 900X notebook via a digital audio interface USBPre 2 which was connected to an external omnidirectional lavaliere clip-on microphone (Sennheiser MKE 2 P-C). The target words were embedded in a carrier phrase and presented in semi-randomised order on display.[237] For every task, *SpeechRecorder* automatically created a separate sound file in a .wav format using a sampling frequency of 44.1 kHz and 16bit quantisation.

As phrase-medial data are of great importance for the analysis, attention was paid to provide a context. The carrier sentences were chosen in order to make the target items

[236] With a total of 1966 tokens there are more measurements than items recorded. This is because some of the items served as the input for the analysis of more than one sound.

[237] In the cases where the recordings were conducted at my place, I additionally used a DELL 2007WFP monitor so that the informants had their own screen where only the task was prompted.

fit into the slots in a maximally natural way.[238] An example is given in Fig. 15. The carrier phrase and the target words are prompted in Standard German. Speakers were instructed to translate the sentence into ZG and fill in the target word – in the example below, *Knall* ‘bang’.[239]

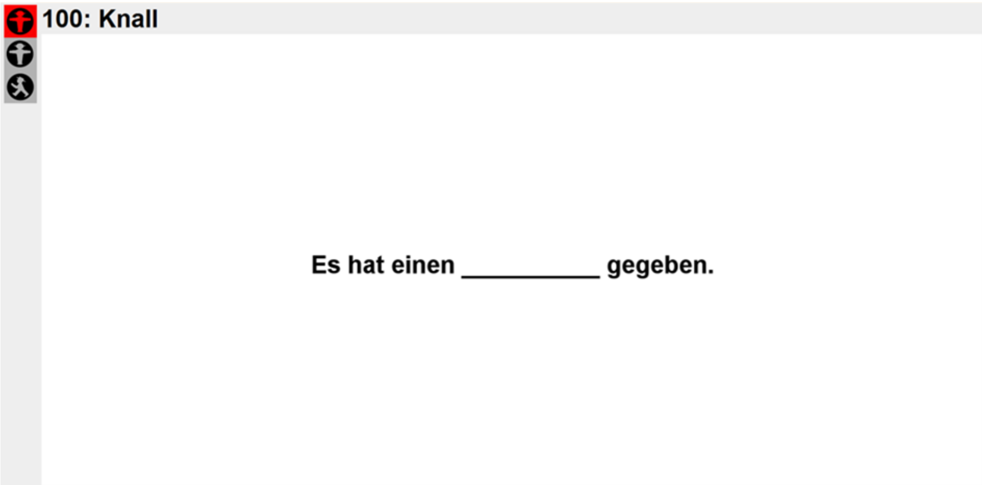


Fig. 15: Screenshot of the carrier phrase *Es hat einen ____ gegeben* ‘there was a ___’ with target word *Knall* ‘bang’ as presented to informants

A total of 361 items were presented to the informants. All tokens were repeated once. Only the second recording was used for the analysis.[240] Since the target consonants appeared in different positions of the word, different carrier phrases were necessary, which accounts for the semi-randomisation. However, efforts were made to control both prosodic and segmental factors. The target word was in nuclear position within the phrase, the number of syllables of the target words, as well as the stress pattern, were kept as constant as possible, and the vocalic environment of the target consonants was sought to vary as little as possible.

The data were manually segmented in Praat (Boersma & Weenink 2014). For each sound file, a text grid was created. As depicted in Fig. 16, separate tiers were set, determining the boundaries

238 Previous studies (cf. e.g. Kraehenmann 2003) often used carrier phrases of the kind “Ich ha ____ gseit” ‘I said ___’. Such contexts are avoided because I conjecture that the elicited target word is prone to be pronounced in citation form. See Kraehenmann & Lahiri (2008) for a similar argument.

239 The key consideration was to reduce the influence of the spelling. Since the informants are unaccustomed to written dialect, it is likely that they would have been susceptible to spelling pronunciation. For reasons of convenience, however, some of the carrier phrases were given in dialect. For complete compilation of the target items and carrier phrases, the reader is referred to the appendix.

240 In a few cases the second recording was flawed. I then used the first recording.

1. of the target word (annotation: "Wort")
2. of the target consonant (annotation: "Konsonant")
3. in the case of stops, the segment was further divided into the portion of closure duration (CD) and voice onset time (VOT) (annotation: "Phase").

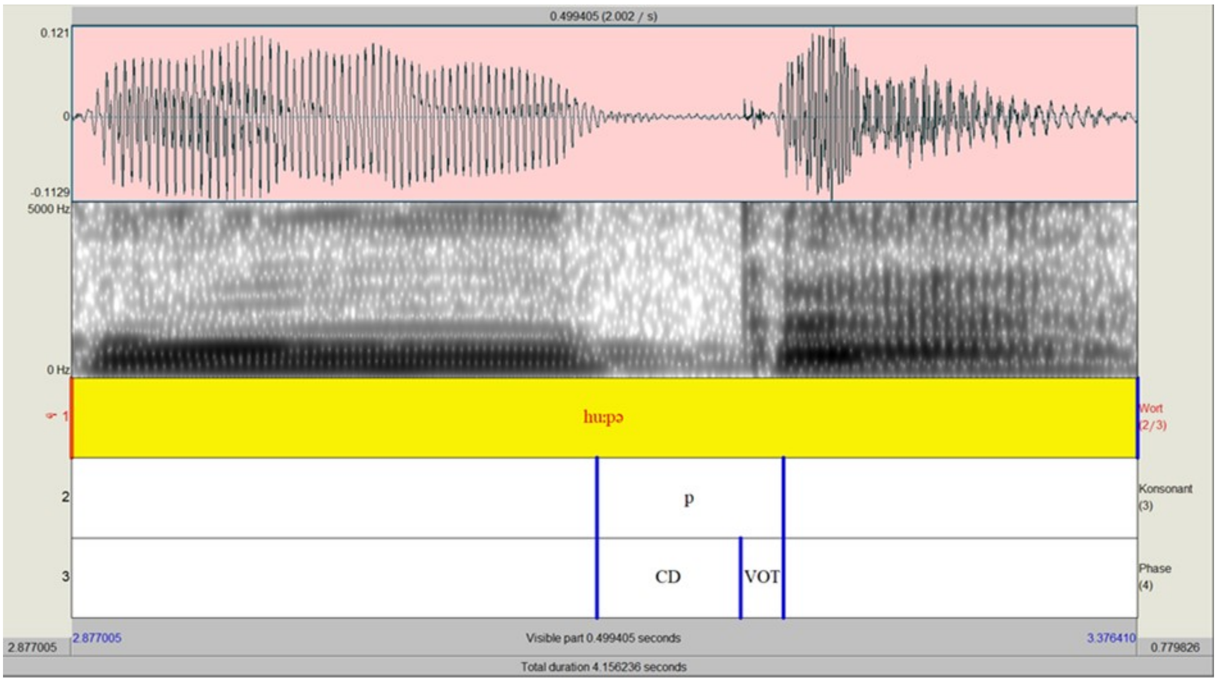


Fig. 16: Praat excerpt of [huːpə] 'hood' (No. 06-316)

The boundaries obtained from spectrogram and waveforms were checked by auditory impression. In cases where both visual information and careful listening led to fuzzy judgements, I adhered to the guidelines provided by Machač & Skarnitzl (2009).

For the fricatives and the sonorants, the segment duration was measured. As has been pointed out previously, stops differ in closure duration while VOT has not been found a relevant factor for the distinction. As can be taken from Fig. 16, stop duration is separated into two phases: Closure duration was measured for all phrase-medial contexts. It cannot be determined in phrase-initial position. The beginning of the closure was identified at the offset of the preceding sound, and the release of the burst marked the end of the closure phase. VOT was measured as the period from the release of the burst to the beginning of the following sound. When the stop preceded a vowel or a sonorant consonant, the onset of vocal fold vibration indicated the end of the VOT phase. When the stop was followed by another stop, the end of the release was marked by the start of the following closure.

The measurements, as well as information on speaker, item and environment, were extracted using a Praat script and imported into Microsoft Excel for further analysis.

Separate statistical analyses were run for stops, fricatives, and sonorants. Since the fixed effects for the obstruents and the model for sonorants vary, I lay them out separately below. In all analyses, I evaluated the fixed effects on the dependent variable of interest with a linear mixed effects model in R (R Core Team 2016), using *lme4* (Bates et al. 2015) and *lmerTest* (Kuznetsova et al. 2016). In all analyses, *item* and *subject* were included as random effects, as well as a by-subject random slope for the effect of the category. The inclusion of *subject* as a random factor controlled for speaker-specific durational variation, in particular, with regard to potential differences in speech rate.

Histograms and scatterplots of the residuals were consulted to check for normal distribution and homoscedasticity. Outliers were back-checked for measurement errors. In order to compare the predictions, they were sometimes excluded from the calculations. Unless reported otherwise, they are generally included in the calculation. The *p*-values were obtained with the anova-function of the *lmerTest* package, using Satterthwaite approximation for degrees of freedom. Hypotheses were tested against an α-level of 0.05.[241]

Pairwise comparison was performed using the *lsmeans* package (Lenth & Love 2017). *p*-values were obtained by the Tukey method for comparing a family of 4 estimates, and degrees of freedom were calculated using the Satterwaithe approximation.

Fixed effects for the obstruents

For each manner of articulation, separate analyses were run for (a) the entire set (neutralised and non-neutralised), (b) according to *position* (word-medial vs at word edge), (c) according to *preceding rhyme* (monopositional vs bipositional). A second similar model was applied to the subset of instances at the word edge, substituting *position* by *phrasal position* (word-initial vs word-final) to determine whether the actual position of the consonant at the left or right edge had an influence on the duration.

[241] Note that the *p*-values of the anova-function used in the text are a mere shorthand in order to give the reader a global overview. For the exact calculation in *lmerTest,* I refer to the appendix.

Table 13 provides a summary of the relevant factors which are entered into the model. If necessary, the coding is given in italics. A more detailed explanation follows below.

	variable	levels	
linguistic factors	category	p pː	f fː
	condition	singleton neutralised singleton *(neutrs)* neutralised geminate *(neutrg)* geminate	
	preceding rhyme *(prec_rhyme)*	V VX	
	position	between within	
	phrasal position	word-final word-initial	
extralinguistic factors	subject		
	item		

Table 13: Fixed and random effects for obstruents

The linguistic factors shown in Table 13 were used as fixed effects while the extralinguistic factors are entered as random effects. In order to gain further insight into the workings of neutralisation, the data were subsequently divided into two subsets: one for all the neutralised stops and the other containing the non-neutralised stops.

The variable *preceding rhyme* provides information about the phonological environment of the target sound: V stands for a preceding short vowel and VX for a preceding long vowel, diphthong, or vowel +sonorant sequence. The variable is not applicable to some word-initial consonants that are preceded by an obstruent (see also fn. 249).

The variable *position* specifies whether a target sound was word-internal (“within”) – or at a word edge (“between”). Note that “word-internal” does not imply that the target sound is in intersonorant position. Also, remember that the instances at word boundaries are produced phrase-medially, thus, “between” denotes word-initial or word-final target items in phrase-medial context.

For analysis on whether word-initial stops behave differently from word-final stops, the factor *phrasal position* is added. It only applies to the subset of “between” instances, i.e. target consonants at the word edge.

Fixed effects for the sonorants

For the statistical analysis of the sonorants, four linguistic factors were determined, and the data were coded accordingly. Table 38 gives an overview. They are detailed in 6.3.4

	variable	levels
linguistic factors	category	n m l
	preceding rhyme *(prec_rhyme)*	V VX
	syllable position *(syll_position)*	Onset Coda
	word position *(wd_position)*	edge non-edge
extralinguistic factors	subject	
	item	

Table 14: Fixed and random effects for sonorants

6.3. Results

In the following, the results of the measurements are presented. The results for the stops, the fricatives and the sonorants are given in three separate subsections. According to Heusler's Law, the same results are to be expected for all obstruents. To separate the data according to the manner of articulation makes it possible to verify this. The subsections 6.3.1 (stops) and 6.3.2 (fricatives) have, in essence, the same structure. I first give a global overview and then discuss the singleton/geminate distinction in non-neutralised and neutralised contexts. For the stops, I will also address the relevance of VOT.

The results for the sonorants are presented in 6.3.4. The investigation is somewhat different, as I assume that the sonorants examined have no underlying singleton/geminate opposition. The central question is whether Winteler's Law can be verified. If, as Winteler assumes, coda consonants differ from those in the onset, this is additional evidence for Moraic Theory.

6.3.1. Stops

The following section presents the results for the stops. The influence of VOT on the singleton/geminate distinction has previously been investigated and will be addressed right at the beginning. An overall impression of the stop data is provided in 6.3.1.2. Section 6.3.1.3 presents the results for the non-neutralised stops. The findings in neutralisation contexts, i.e. where Heusler's Law applies, are presented in 6.3.1.4.

6.3.1.1. Voice Onset Time (VOT)

The mean VOT values of the items tested are given in Table 15. With a difference of less than 5 ms, it does not fall within the 10–40 ms range of "just-noticeable difference" of segment duration reported by Lehiste (1970: 13). Furthermore, and little surprisingly, the average duration is less than 30 ms, which has been proposed to be a threshold for the perception of aspiration (Lisker & Abramson 1964; Cho & Ladefoged 1999).

	mean VOT (ms)	SD	n
p	24.15	13.23	383
pː	27.64	19.86	348

Table 15: VOT (in ms) of singleton and geminate labial stops

The Standard Deviation (SD) shows some dispersion, especially for the geminates. Albeit the geminate VOT values are more dispersed than those of the singleton, Fig. 17 shows that the VOT values gather around 20 ms for both categories.[242]

[242] Note that these values are rather high for labial stops which are reported to have comparatively low VOT values (Cho & Ladefoged 1999, and references therein). Enstrom & Spörri-Bütler (1981) also measured very low values for bilabial stops. The difference may be due to the fact that they only took word-initial instances into account. A cursory inspection of (prepausal) word-initial labial stops in the corpus reveals a mean VOT of 15.33 ms (n =22).

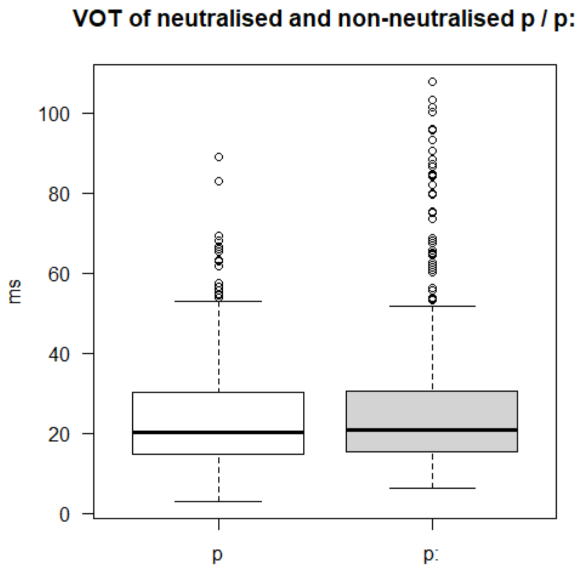


Fig. 17: Overall duration of VOT for labial stops[243]

The mean VOT for singletons and geminates in both neutralised and non-neutralised position, are given in Table 16. Apart from non-neutralised geminates, the difference is again less than 30 ms and thus in the range of non-aspirated sounds. With a mean VOT of 31.37 ms, the non-neutralised geminates are just above the 30 ms threshold. Ladefoged & Cho (1999: 214) state that stops with VOT values above 50 ms are "slightly aspirated". It is thus fair to conclude that the ZG stops are unaspirated.[244]

		mean VOT (ms)	SD	n
p	neutralised	23.76	10.5	184
	non-neutralised	24.52	15.35	199
pː	neutralised	23.64	10.84	168
	non-neutralised	31.37	25.02	180

Table 16: VOT (in ms) of neutralised and non-neutralised singleton and geminate labial stops

The VOT values according to their condition as neutralised, and non-neutralised, respectively, are provided in Fig. 18. Again, the median is around 20 ms for all four combinations.

243 Boxplots are created by the boxplot function provided in R (Graphics Package, R Core Team). By default, values that are outside 1.5*IQR are plotted as outliers.

244 As mentioned previously (cf. fn. 92), Ladd & Schmid (2018) report aspiration. Such instances, however, did not occur in my material.

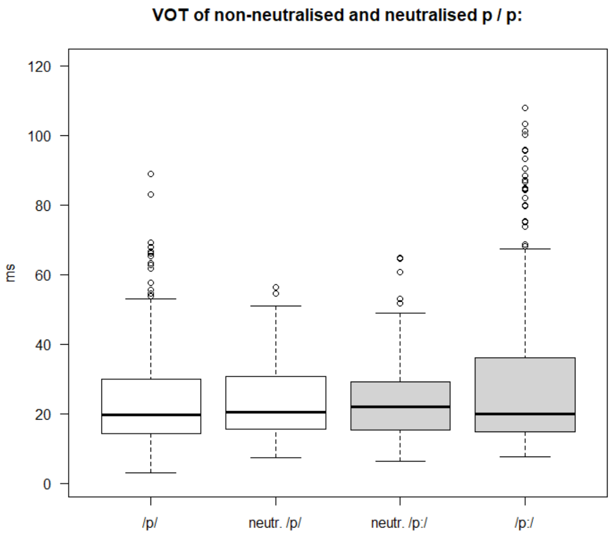


Fig. 18: VOT of non-neutralised and neutralised singleton (white) and geminate (grey) labial stops

Fig. 19 shows the VOT by speaker. The median is comparable for all speakers and conditions. However, non-neutralised geminates show large inter-subject variability.

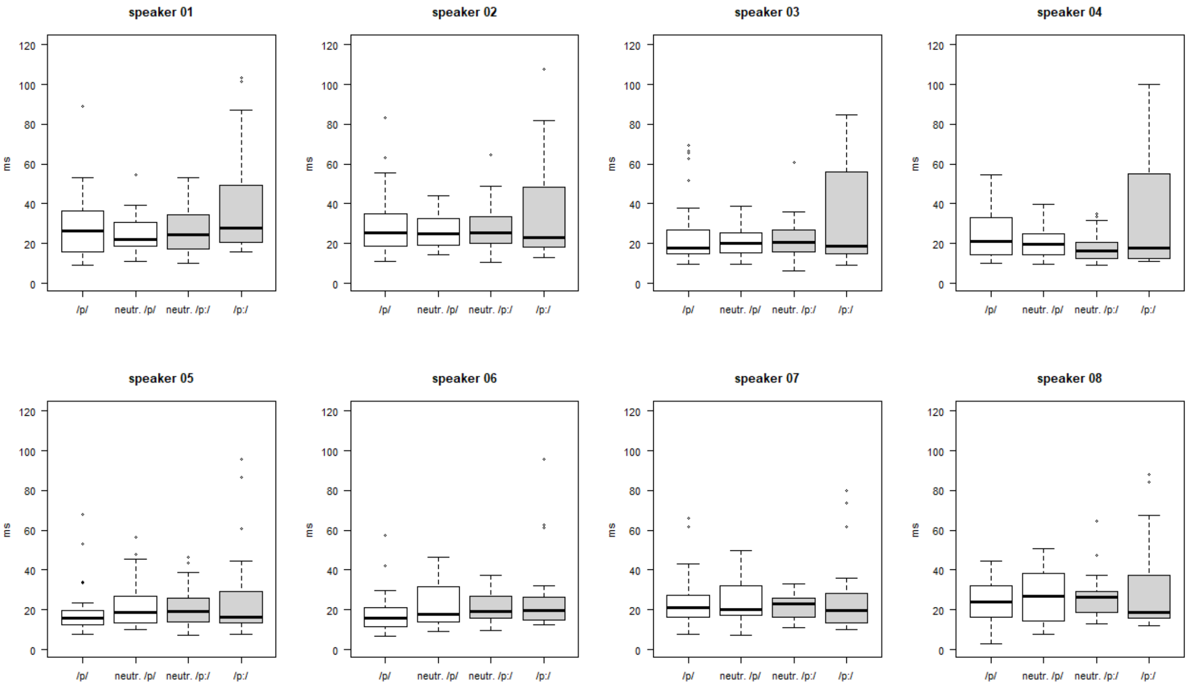


Fig. 19: Individual plots for VOT of non-neutralised and neutralised singletons (white), and neutralised and non-neutralised geminate (grey) labial stops

Statistical analysis revealed a significant main effect for the geminate condition (cf. App. 1). Post-hoc pairwise comparison also showed that the VOT values in the geminate condition significantly differ from those in the neutralised condition, cf. Table 17.

Contrast	estimate	SE	df	t.ratio	p.value
singleton – neutralised singleton	1.06	1.67	676	0.64	0.92
singleton – neutralised geminate	2.41	2.83	47	0.85	0.8307
singleton – geminate	-6.80	2.81	45	-2.42	0.0874
neutralised singleton – neutralised geminate	1.34	2.86	49	0.47	0.9654
neutralised singleton – geminate	-7.86	2.83	47	-2.78	0.0382
neutralised geminate – geminate	-9.20	1.77	656	-5.21	<.0001

Table 17: Pairwise comparison of the estimated marginal means for VOT (in ms) among the four conditions *singleton, neutralised singleton, neutralised geminate,* and *geminate*

This is a surprising result. Closer inspection of the outliers above the 60 ms margin revealed that they occur almost exclusively in phrase-medial contexts where the word-final stop is followed by a sonorant consonant. The excerpt from Praat in Fig. 20 serves as an example. In fact, all but one speaker have VOT values above 30 ms in this environment. I have no explanation for it, and it has to my knowledge not been reported in previous investigations.[245]

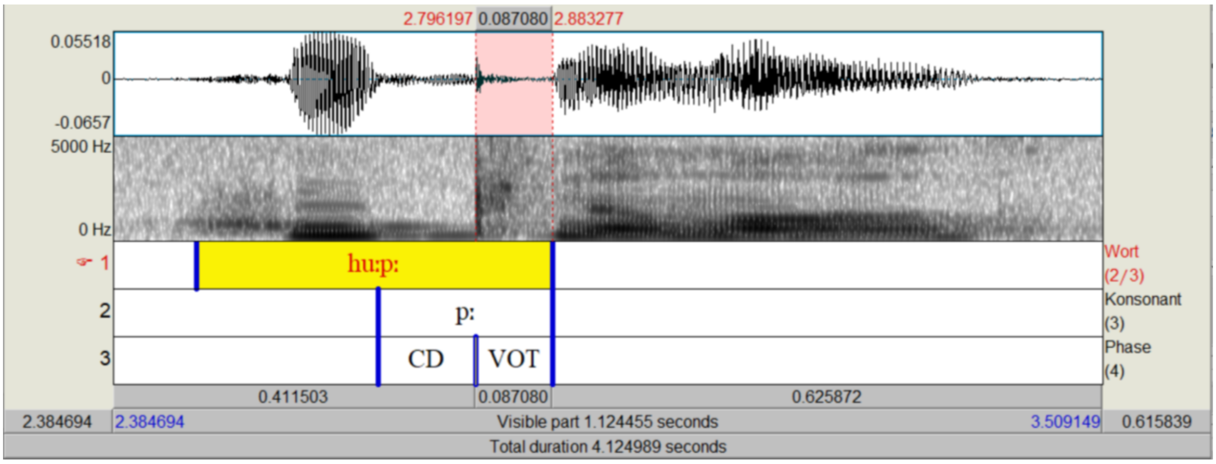


Fig. 20: Praat excerpt of [huːpː nompːl] 'honk again' (No. 01-042)

To check whether this particular environment caused the statistical outcome, all outliers above 60 ms were removed from the calculation.[246]

245 Stephan Schmid (p.c.) reports similar observations. If geminates are preceded by a nasal sonorant, the vocal fold vibration sometimes restarts with a delay to the release, creating a slightly affricated or aspirated sound.

246 Two additional outliers (No. 02-084 and No. 04-087) with aberrant behaviour were identified and have been excluded, too. In both instances, a word-final geminate was followed by a glottal stop instead of a vowel. Glottal stop insertion does not exist phrase-medially, however, it occurs in phrase-initial position. This indicates that the speakers articulated the target word in an isolated fashion. Arguably, word-finality has an impact on VOT. Kraehenmann (2001: 120) reports longer VOT for stops in absolute word-final position.

A new statistical analysis showed no significances (cf. App. 2). Post-hoc pairwise comparisons reveal that all differences in estimated marginal means are insignificant, cf. Table 18.

Contrast	estimate	SE	df	t.ratio	p.value
singleton – neutralised singleton	-1.37	1.09	648	-1.25	0.59
singleton – neutralised geminate	-0.72	1.91	46	-0.38	0.98
singleton – geminate	0.17	1.92	47	0.09	1.00
neutralised singleton – neutralised geminate	0.65	1.92	47	0.34	0.99
neutralised singleton – geminate	1.54	1.93	48	0.80	0.85
neutralised geminate – geminate	0.89	1.20	623	0.74	0.88

Table 18: Pairwise comparison of the estimated marginal means for VOT (in ms) among the four conditions *singleton, neutralised singleton, neutralised geminate, and geminate* after removal of all outliers above 60 ms

With this restriction, we can state that the data confirms earlier findings. VOT does not play a crucial role for the singleton/geminate distinction.

6.3.1.2. Closure duration (CD)

As stated above, the relevant correlate for the singleton/geminate distinction is closure duration. Note that all the instances are phrase-medial. Neither word-initial nor word-final stops that occur at phrase edges are included. Table 19 gives an overview of the number of tokens for the stop data.[247]

[247] The word list is in the appendix.

			neutralised		non-neutralised	
			singleton	geminate	singleton	geminate
			184	168	199	180
position	word-internal 'within'		48	48	48	47
	word edge[248] 'between'	word-final	88	72	112	94
		word-initial	48	48	39	39
preceding rhyme[249]	mono-positional (V)		56	40	73	54
	bipositional (VX)		80	80	126	126

Table 19: Number and distribution of the stops according to linguistic factors

The stops are investigated along two cross-cutting factors: *position* refers to the position of the stop in the word. It is used to determine whether the same pattern appears within words and across word boundaries. *Preceding rhyme* examines the influence of the structure of the preceding rhyme.

In order to analyse whether word-initial stops behave differently than word-final stops, the subset *word edge* is used.

The CD of singleton and geminate stops in their neutralised and non-neutralised condition is depicted in Fig. 21. In the neutralised condition, the CD of geminates is somewhat longer than the CD of the singletons. Compared to non-neutralised singletons and geminates, however, they are both somewhere in between. Put differently, singleton stops are longer in the neutralised condition, and geminate stops are shorter.

248 In phrase-medial contexts.

249 96 word-initial items (48 singletons and 48 geminates) are preceded by an obstruent. They are set NA ("not applicable") for this parameter.

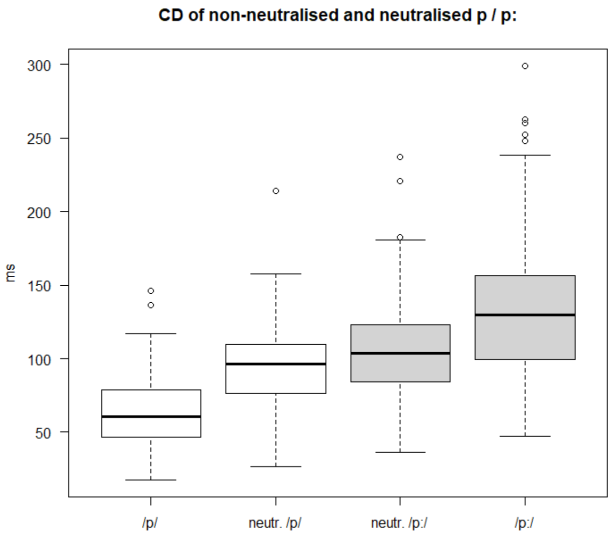


Fig. 21: CD of non-neutralised and neutralised singleton (white) and geminate (grey) labial stops

Individual plots for all eight speakers in Fig. 22 show that despite the inter-subject variation, the pattern remains constant: the CD is shortest for singletons and longest for geminates. In the neutralised condition, both categories have an intermediate CD.

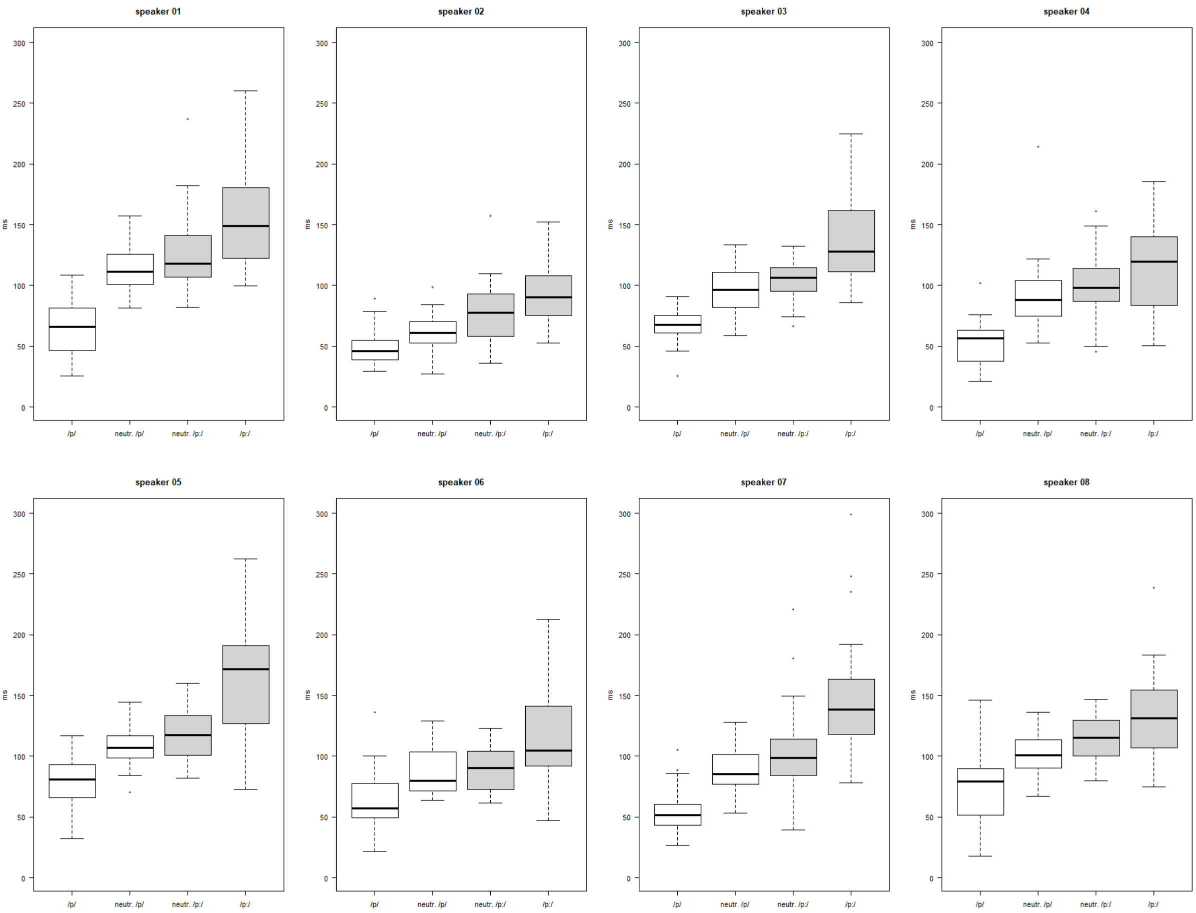


Fig. 22: Individual plots for CD of non-neutralised and neutralised singletons (white), and neutralised and non-neutralised geminate (grey) labial stops

The above boxplots thus confirm the impression formulated by Heusler and his successors that the neutralised consonants are of some intermediate duration. Note that neutralised singletons and geminates slightly differ. Such a difference has previously been reported (Kraehenmann & Jaeger 2003; Kraehenmann & Lahiri 2008). In the following sections, I will further investigate which factors influence neutralisation.

Pairwise comparisons between the four conditions confirm that the phonological contrast between geminates and singletons is phonetically manifested by closure duration, cf. Table 20 below. As expected, the highest difference is between non-neutralised singletons and geminates (see column “estimates”). The analysis furthermore reveals that the intermediate neutralised stops significantly contrast with both, the non-neutralised geminates as well as the non-neutralised singletons. Comparison of the two neutralised conditions, on the other hand, shows no significance.

Contrast	estimate	SE	df	t.ratio	p.value
singleton – neutralised singleton	-34.18	2.74	711	-12.48	<.0001
singleton – neutralised geminate	-52.90	8.48	42	-6.24	<.0001
singleton – geminate	-68.22	8.46	41	-8.06	<.0001
neutralised singleton – neutralised geminate	-18.72	8.50	42	-2.20	0.1392
neutralised singleton – geminate	-34.04	8.48	42	-4.01	0.0013
neutralised geminate – geminate	-15.32	2.91	712	-5.26	<.0001

Table 20: Pairwise comparison of the estimated marginal means for closure duration (in ms) among the four conditions *singleton, neutralised singleton, neutralised geminate,* and *geminate*

The statistical evaluation showed no three-way interaction (App. 3). There was a significant interaction for *condition* and *position* as well as for *condition* and *preceding rhyme*.

The boxplots in Fig. 23 shows differences in the duration according to the parameters *condition* and *position,* as well as *condition* and *preceding rhyme*.

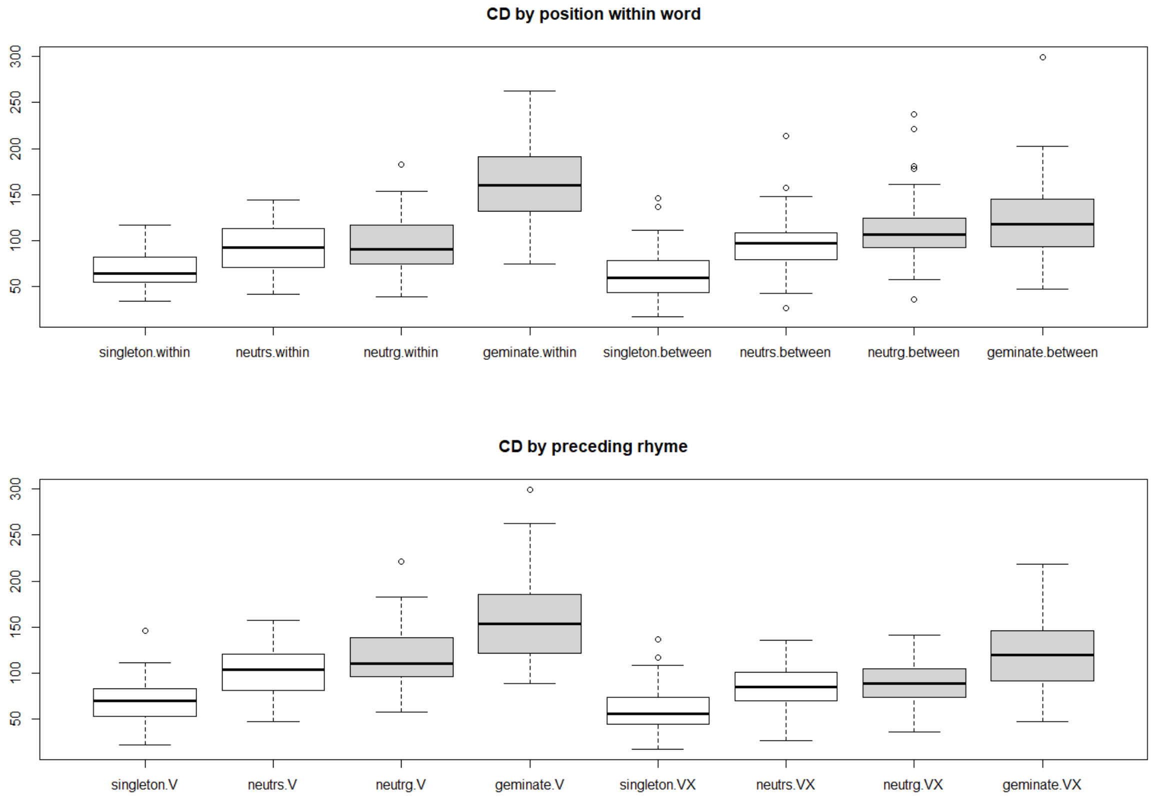


Fig. 23: CD of bilabial stops in all conditions by *position* (above) and by *preceding rhyme* (below)

As can be seen in Fig. 23, from the word-medial instances, geminates stand out. Their deviant behaviour is statistically significant (App. 4). While *position* has no significant effects on singletons or neutralised stops, word-medial geminates are significantly longer than when they straddle a word boundary.

Fig. 23 also shows that the preceding rhyme influences the duration of the following stop. If preceded by a bipositional rhyme, they are generally shorter than after a monopositional short vowel. Again, the geminate is most affected by the preceding environment (App. 5).

Since the main interest of this investigation is concerned with neutralisation and which factors (if any) influence the CD of neutralised consonants, the data were split into a set containing the neutralised sounds and a set containing the non-neutralised sounds.

6.3.1.3. Intersonorant (non-neutralised) /p/ and /pː/

In intersonorant environment, the contrast is maintained. Fig. 24 shows the average CD of geminates and singletons in a contrasting environment. The CD of geminates is about twice as long as the CD of singletons.

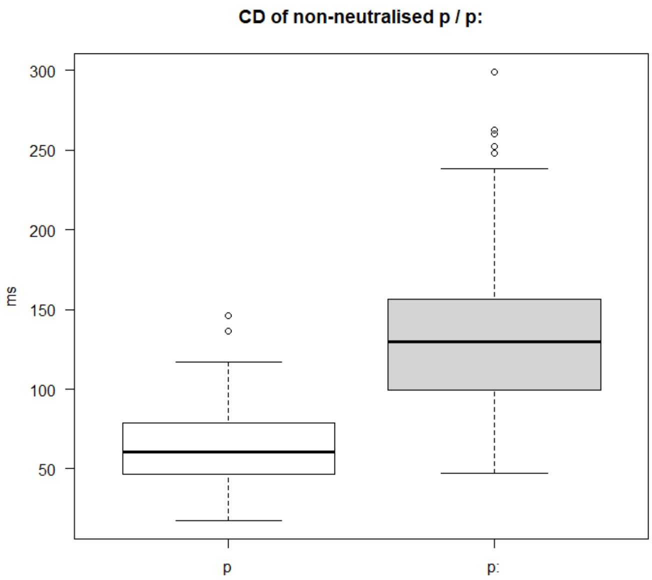


Fig. 24: Overall CD of intersonorant singleton and geminate labial stops

If we look at the speaker-specific plots in Fig. 25, we find considerable differences. However, the CD of the geminate is consistently longer than its singleton counterpart. Crucially, there is no overlap between the boxes, and the median of the geminate values is almost always above the upper whiskers of the singleton value.

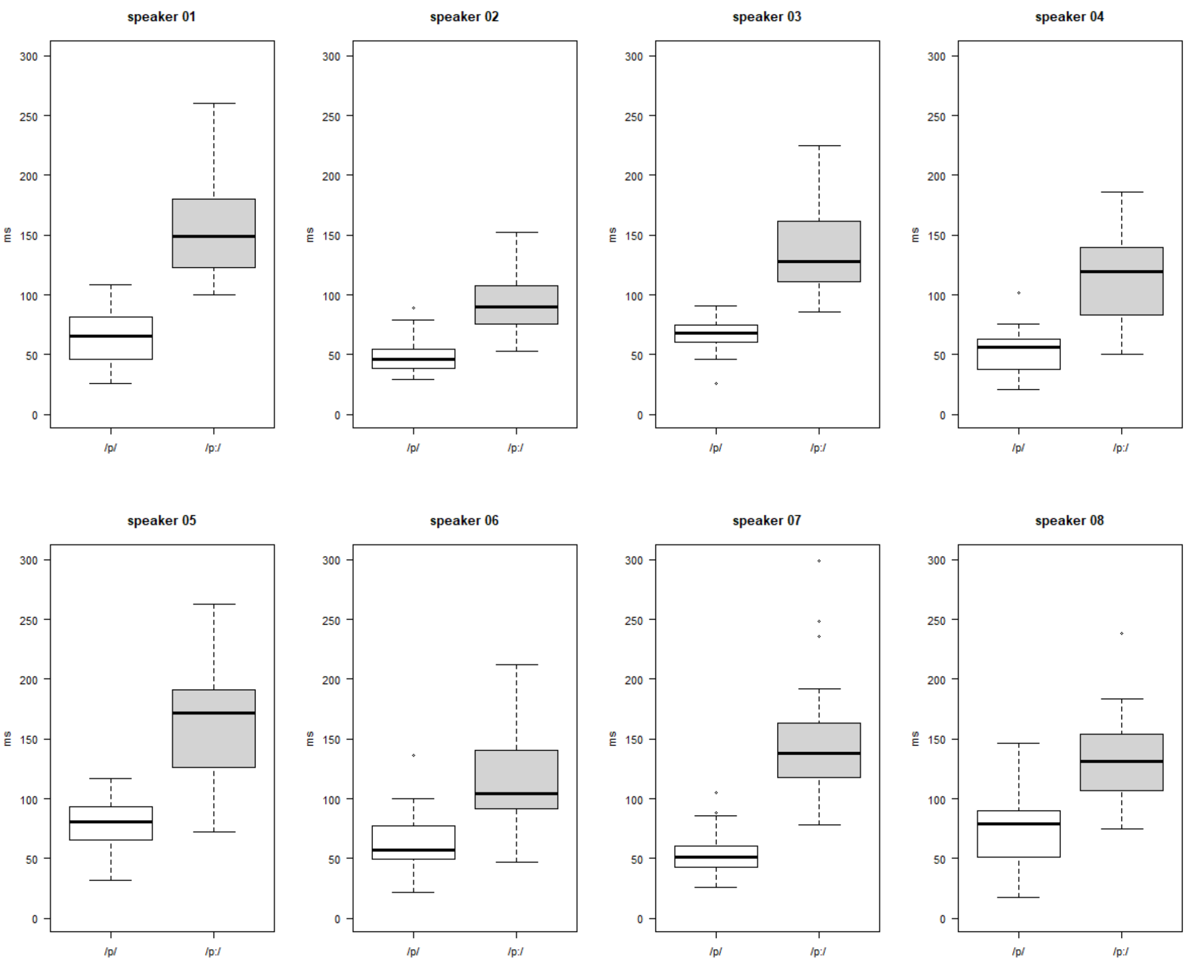


Fig. 25: Individual plots for CD of intersonorant singleton and geminate labial stops

The speaker-specific ratios in Table 21 show that the average ratio of (intersonorant) geminate vs singletons is approximately 2:1. However, there is individual variance, ranging from approximately 1.8 up to 2.8.

Speaker	mean singleton /p/	mean geminate /pː/	Ratio gem : sing
01	64.27	155.10	2.41
02	48.37	95.13	1.97
03	66.56	134.63	2.02
04	52.67	113.34	2.15
05	78.22	160.54	2.05
06	62.61	117.70	1.88
07	54.04	149.17	2.76
08	74.19	132.82	1.79
mean CD	62.63	132.58	2.12

Table 21: Mean CD (in ms) of intersonorant geminate and singleton labial stops and ratio by speaker

To investigate whether closure duration depends on the environment, we will again focus on the position of the target consonant within the word and the shape of the preceding rhyme. With regards to the former, the question is whether there is any difference between word-medial stops and stops at the word edges, followed, or preceded by a sonorant sound. Kraehenmann (2003) has longer durations for word-medial stops. As for the latter, it has been reported that geminate consonants are shorter when they are preceded by a bipositional rhyme. The results are given in Table 22.

		V_	SD	VX_	SD	ratio V_ : VX_
p	word-medial	69.78	19.07	55.58	22.60	1.26
	word edge	69.70	23.55	67.18	18.52	1.04
pː	word-medial	201.04	47.44	147.39	36.84	1.36
	word edge	141.61	40.72	112.60	33.56	1.26

Table 22: Mean CD (in ms) standard deviation (SD) and ratio for intersonorant singleton and geminate stops in word-medial and word-final position preceded by a monopositional (V) or bipositional (VX) rhyme

Word-medial geminates are longer than those at word edge, and they are longer when preceded by a short vowel. As for the singletons, neither factor seems to influence the closure duration substantially. Compared to all other positions, however, they are shorter when at word edge and preceded by a bipositional rhyme.

Let us first look at the CD with respect to the position of the target consonant within the word. Fig. 26 shows that singletons are consistently shorter than geminates. Furthermore, the position of the word does not seem to affect singletons. In contrast, word-medial geminates are longer than those at word edges.

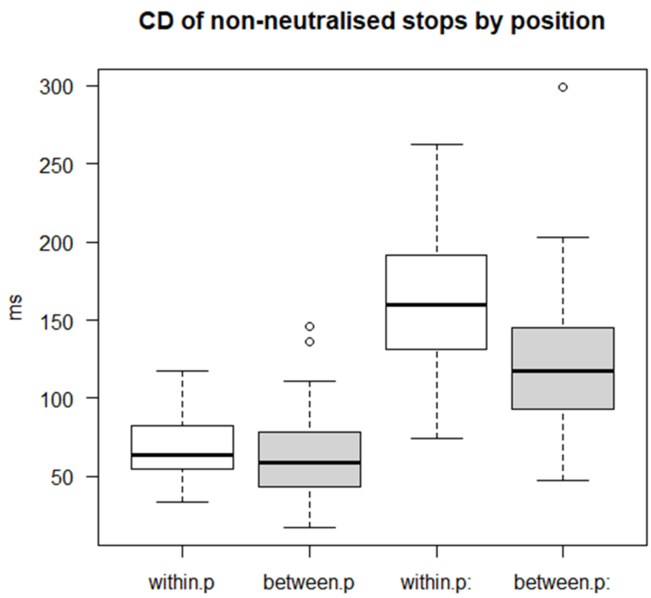


Fig. 26: CD of intersonorant singleton and geminate labial stops according to the position within the word ('within' = word-internal, 'between' = at word edge, i.e., straddling a word boundary)

The statistical analysis revealed main effects for *condition* and *position* ($F(1,21) = 68.51$; $p < .0001$, and $F(1,23) = 14.51$; $p < .0001$). Under the assumption that CD is the correlate for the contrast, this is not surprising. There is a significant interaction between *category* and *position* ($F(1,23) = 8.84$; $p = .00683$). The estimated difference is 6 ms for singletons in word-medial position. At word edge, word-medial geminates are 48 ms longer than across word boundaries (App. 6). The position of the geminate within the word thus impacts its closure duration.

ZG singleton and geminate stops occur word-initially and word-finally. Word-initial data are different from word-final instances in that the target consonant precedes the stressed syllable. This might influence the outcomings. Table 23 shows that word-initial singletons are somewhat shorter than their word-final counterparts. Geminates, on the other hand, exhibit the reverse pattern as the average duration is longer word-initially than word-finally. The boxplot in Fig. 27 below visualises this.

	word-final (SD)	word-initial (SD)	mean
p	63.65 (22.57)	53.03 (26.07)	60.91
pː	113.85 (36.31)	137.84 (36.85)	120.89

Table 23: Mean CD (in ms) and standard deviation for intersonorant singleton and geminate stops in word-final and word-initial position

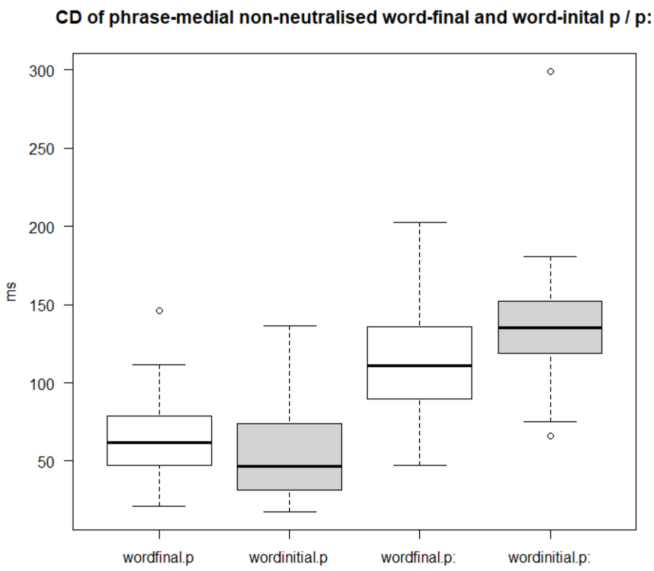


Fig. 27: Closure duration of intersonorant word-final and word-initial stops

Statistical analysis was conducted using the subset of phrase-medial non-neutralised consonants. Instead of *position, Phrasal Position* was set as a fixed effect (App. 7). However, while *condition* has a highly significant main effect ($F(1,12) = 37.3$; $p < .0001$), the position in the word reaches no statistical significance ($F(1,9) = 0.55$; $p = .4767$). Also, there is no significant interaction ($F(1,9) = 3.15$; $p = .1107$).[250]

The CDs for stops in word-medial (e.g. ʃɒpət ‘scratch (1.pl.)’ – ʃnɒpːət ‘catch (1.pl.)’), word-final (e.g. ʃɒp əmɒːl ‘scratch once’ – ʃnɒpː əmɒːl ‘catch once’), and word-initial (e.g. tə pɒsː ‘the bass’ – tə pːɒsː ‘the passport’) positions are summarised in Fig. 28. It shows that medial intersonorant geminates are consistently longer than their singleton counterparts. This holds for word-medial as well as for phrase-medial stops. As for the latter, the contrast is maintained irrespective of whether the stop is word-final or word-initial.

[250] It should be noted, however, that the database for word-initial stops is sparse (n = 78, compared to n = 206 for word-final instances).

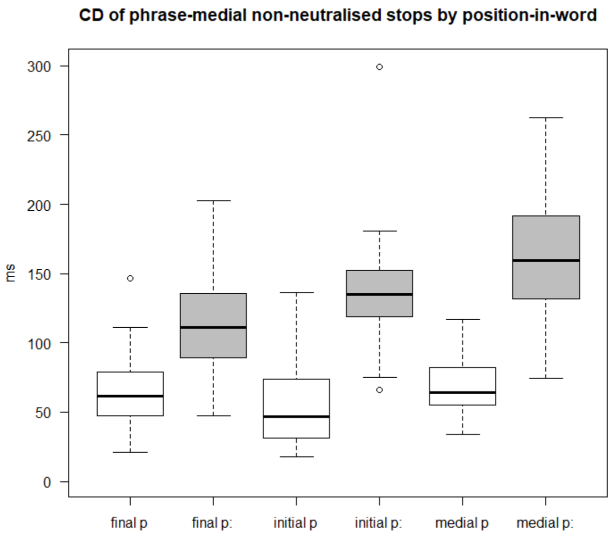


Fig. 28: CD of intersonorant labial stops by position within word

The speaker-specific plots in Fig. 29 below show that the median of the singleton stops is always lower than the median of the geminate. This indicates that all speakers differentiate between singletons and geminates in all positions of the word.

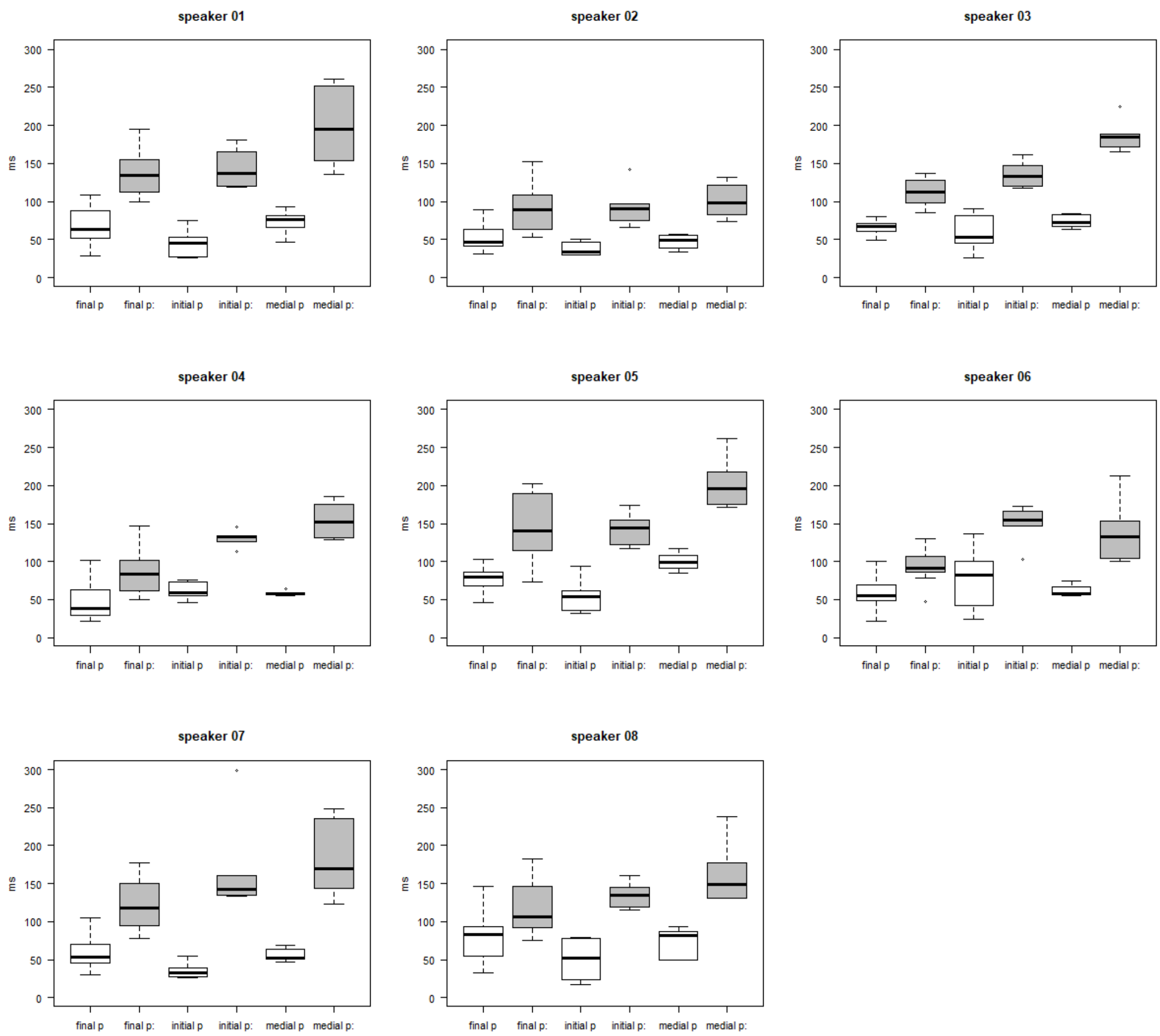


Fig. 29: Individual plots for CD of intersonorant labial stops by position within word

Let us now turn to how the preceding rhyme affects the CD. Fig. 30 shows that singletons are consistently shorter than geminates. However, singletons and geminates are on average somewhat shorter when preceded by a bipositional rhyme.

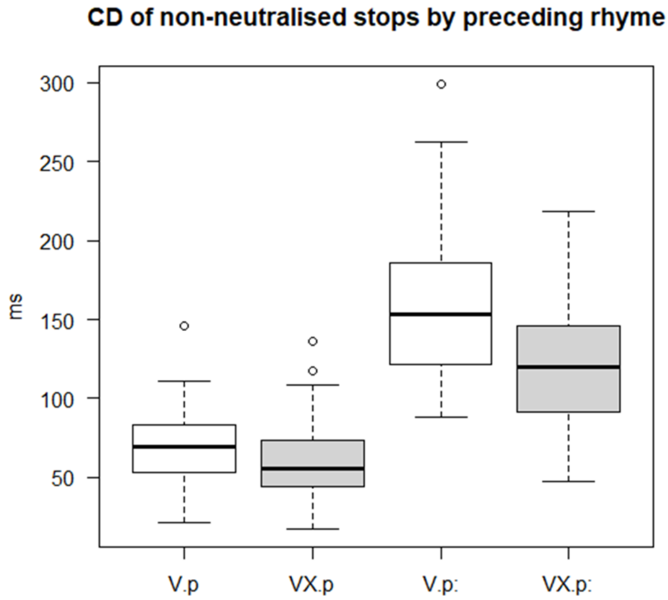


Fig. 30: CD of intersonorant singleton and geminate labial stops preceded by monopositional (V) or bipositional (VX) rhyme

Statistical analysis shows that geminates are longest after short vowels (App. 8). *Condition* and *preceding rhyme* are both main effects (F(1,25) = 61.34; p < .0001, and F(1,135) = 22.82; p < .0001). There is an interaction between *condition* and *preceding rhyme:* the estimated difference between geminates preceded by a short vowel compared to those preceded by a bipositional rhyme is 37 ms. For singletons, the difference is 12 ms. The interaction is significant (F(1,135) = 5.66; p = .01879). While the make-up of the preceding rhyme has no significant effect on singletons, it influences the closure duration of the geminates. This is, again, an expected result. It supports the view that singletons are entirely syllabified in the following onset and therefore remain unaffected by the structure of the preceding syllable. The rhymal shape, however, obviously has some bearing on the duration of geminates, in that they are “squeezed” somewhat after long vowels. However, their duration still exceeds the duration of singletons.

Before we turn to the neutralised data, let us briefly summarise the findings so far:

– Intersonorant (i.e. non-neutralised) singleton and geminate stops differ significantly in closure duration (CD)
  – The closure duration of non-neutralised stops is influenced by
    – the position within the word (word-medial vs at word edge)
      There is an interaction between *position* and *condition:* compared to singletons, the CD of geminate stops is significantly shorter when at word

edge. Geminates that straddle a word boundary are significantly shorter than those within a word. The CD of singleton stops, however, remains relatively constant.

  - The position of the stop as word-initial or word-final does not play a significant role

- the structure of the preceding rhyme (monopositional vs bipositional)

  There is an interaction between *condition* and *preceding rhyme:* compared to singletons, the CD of geminate stops is significantly shorter after a bipositional rhyme. The shape of the preceding rhyme thus has a greater impact on geminates than on singletons.

  The interaction is indicative for the heterosyllabic representation of non-neutralised geminates: while the preceding rhyme has no effect on singletons since they are entirely syllabified in the onset of the following syllable, geminates are affected by the structure of the preceding rhyme. This may be a temporal compensation effect (e.g. Port et al. 1980) in order to keep moraic duration constant. Future research will shed further light on the subject.

6.3.1.4. Neutralised /p/ and /pː/

Heusler's Law predicts neutralisation when an obstruent is immediately preceded or followed by another obstruent. The overall distribution of neutralised stops is given in Fig. 31. Compared to the non-neutralised stops in Fig. 24, it is evident that the neutralised values converge on a medium duration.

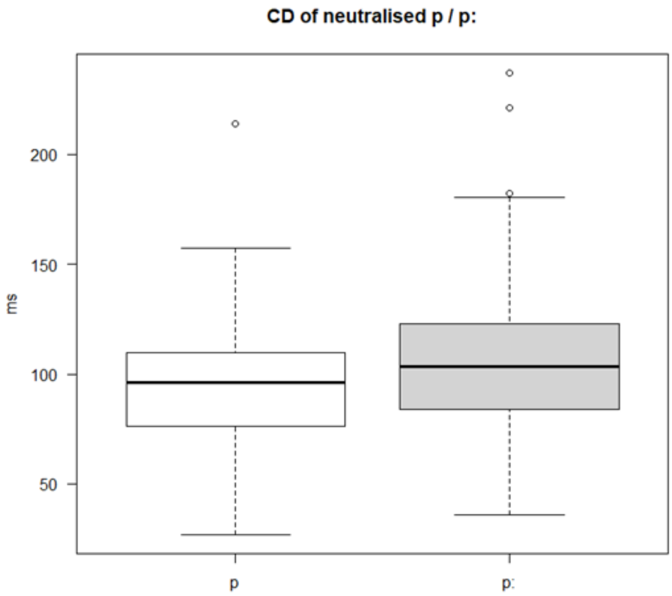


Fig. 31: Overall CD of neutralised labial stops

Fig. 32 shows that, despite some variability, the speakers consistently neutralise in the respective environment and they all do so in the same way: neutralised singletons are longer than their non-neutralised counterparts, while the opposite holds for geminates.

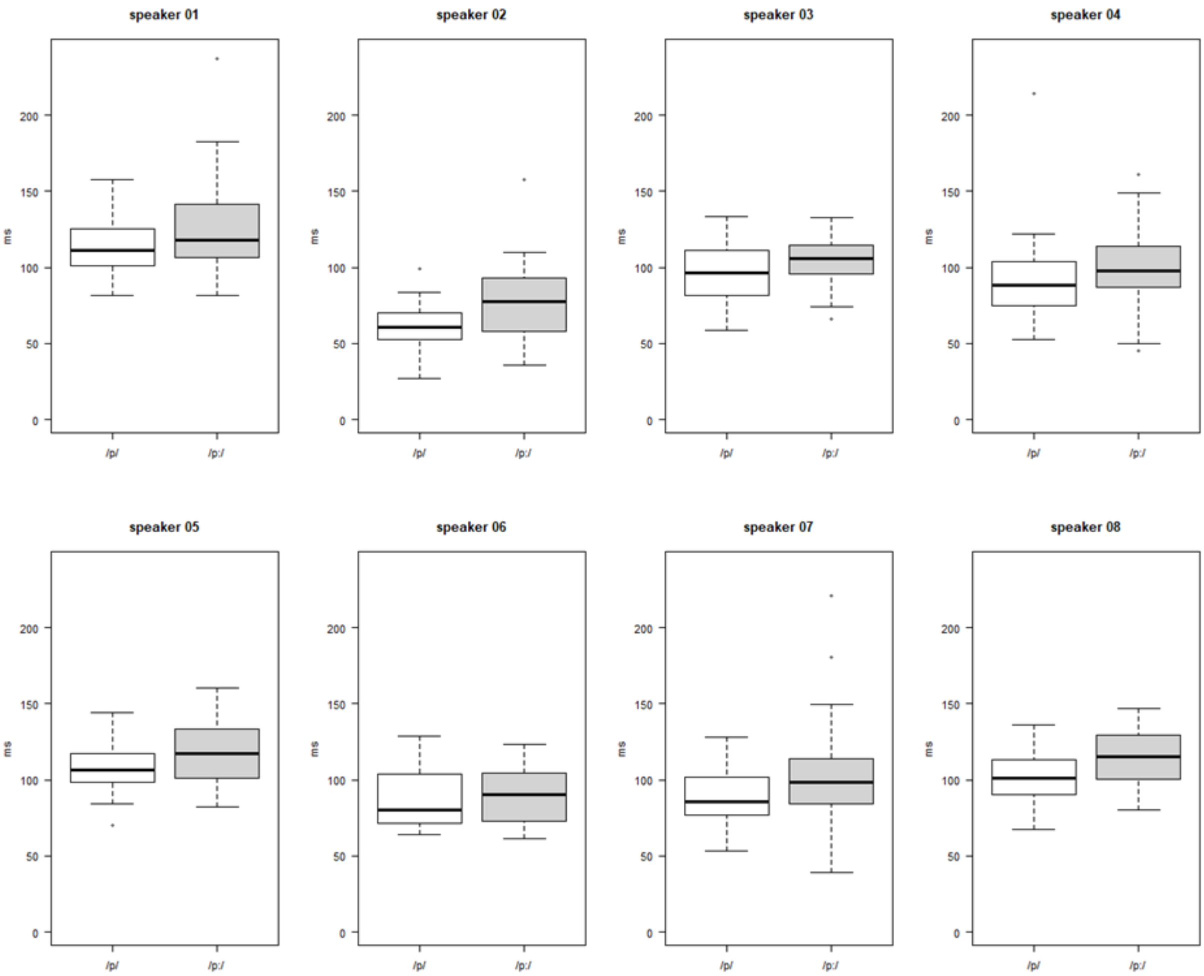


Fig. 32: Individual plots for CD of neutralised singleton and geminate labial stops

Table 24 shows the speaker-specific ratios. Recall from Table 21 that the average ratio of non-neutralised geminate vs singleton stops is roughly 2:1. In a neutralising position, however, the ratio ranges from 1 to 1.3. For comparison, the respective non-neutralised values are given in brackets.

Speaker	mean singleton /p/		mean geminate /pː/		Ratio gem : sing	
01	131.43	(64.27)	114.35	(155.10)	1.15	(2.41)
02	77.90	(48.37)	61.07	(95.13)	1.28	(1.97)
03	104.48	(66.56)	96.74	(134.63)	1.08	(2.02)
04	100.91	(52.67)	94.93	(113.34)	1.06	(2.15)
05	117.28	(78.22)	109.58	(160.54)	1.07	(2.05)
06	90.27	(62.61)	87.60	(117.70)	1.03	(1.88)
07	105.89	(54.04)	88.97	(149.17)	1.19	(2.76)
08	113.76	(74.19)	102.20	(132.82)	1.11	(1.79)
mean CD	105.24	(62.63)	94.51	(132.58)	1.11	(2.12)

Table 24: Mean CD (in ms) of neutralised geminate and singleton labial stops and ratio by speaker

According to Heusler's Law, neutralisation should apply in any environment. Table 25 gives the mean closure durations for word-medial and word-final items when preceded by a short vowel or a bipositional rhyme. Note that word-initial stops have to be treated separately because they are preceded by an obstruent. The average CDs of word-initial stops are presented in Table 26, below.

		V_	SD	VX_	SD	example
p	word-medial	106.29	27.88	84.16	23.65	ʃɒpʃ / loːpʃ
	word-final	101.95	26.47	85.58	20.82	ʃɒp sofortː / loːp sofortː
pː	word-medial	116.00	31.30	84.65	26.66	ʃnɒpːʃ / huːpːʃ
	word-final	120.79	35.90	92.25	21.01	ʃnɒpː sofortː / huːpː sofortː

Table 25: Mean CD (in ms) and standard deviation (SD) for neutralised singleton and geminate stops in word-medial and word-final position preceded by monopositional (V) or bipositional (VX) rhyme

		CD	SD	example
p	word-initial	100.22	24.83	sæk pɒsː
pː	word-initial	120.60	26.98	sæk pːɒsː

Table 26: Mean CD (in ms) and standard deviation (SD) for neutralised singleton and geminate word-initial stops

The tables above show that the difference between the singleton and geminate category is narrowed down considerably. The CD of the neutralised stops centres around 100 ms. Stops that are preceded by a bipositional rhyme are shorter than those preceded by a single short vowel. Word-initial stops have about the same duration as word-final ones. We will look at the different factors in turn.

The boxplots in Fig. 33 show the closure duration of neutralised stops according to their position within the word.

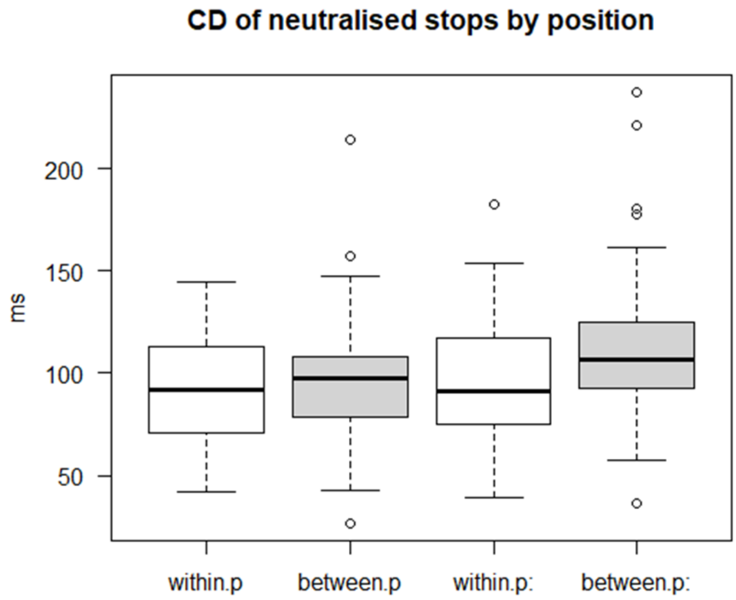


Fig. 33: CD of neutralised singleton and geminate labial stops according to the position within the word ('within' = word-internal, 'between' = at word edge, thus straddling a word boundary)

The statistical analysis reveals no significances. Neither *condition* nor *position* have significant main effects (F(1,23) = 1.63206; p = .2144; F(1,23) = 1.25332; p = .2747) The two factors do not interact significantly (F(1,23) = 0.44484; p = .5115).

The estimated difference between the CD of singletons and geminates is 4 ms for the word-medial context and 11 ms across word boundaries. Word-medial instances are estimated 2–9 ms shorter than those at the word margins, cf. App. 9.

The phrase-medial set comprises both word-initial and word-final data. They are separated in Fig. 34. It can be seen that word-medial obstruents behave the same regardless of whether they are in the onset or in the coda. In order to gain statistical information, the subset was looked at separately, and the factor *Phrasal Position* was added into the model. The statistical analysis shows no significant differences, cf. App. 10.

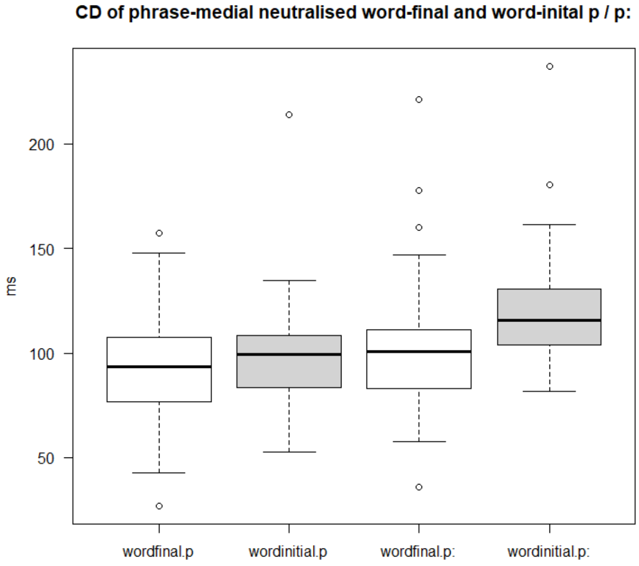


Fig. 34: CD of neutralised word-final and word-initial stops

Fig. 35 shows the CD depending on the preceding rhyme. Neutralised singleton and geminate stops are longer when preceded by a monopositional rhyme. The difference between singletons and geminates remains relatively constant, irrespective of the structure of the preceding rhyme. This is not surprising. We have already seen that non-neutralised geminates are shorter after a bipositional rhyme. Neutralised singletons after short vowels are associated with a mora by WbP. Under the assumption of Moraic Theory, we expect them to be longer in this position. This is a consequence of the prediction that in coda position after monopositional rhymes, singleton and geminate consonants are structurally equal.

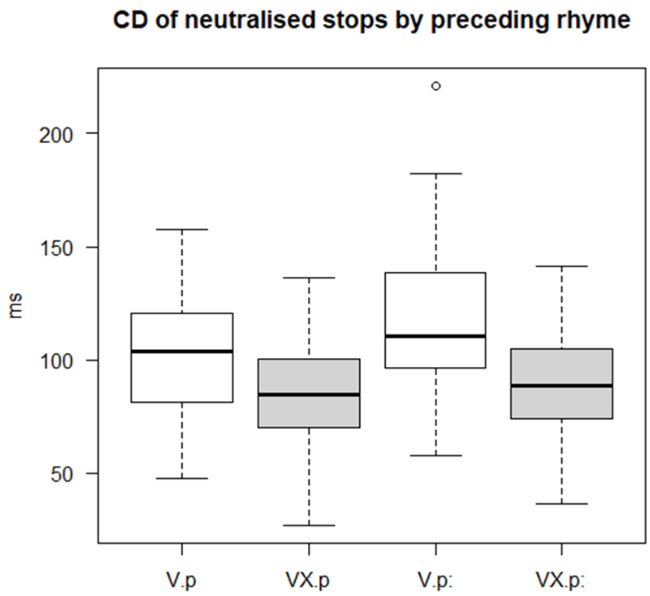


Fig. 35: CD of neutralised singleton and geminate labial stops preceded by monopositional (V) or bipositional (VX) rhyme

Statistical analysis confirms the visual impression. There is a highly significant main effect for *preceding rhyme* ($F(1,17) = 59.752$; $p < .0001$). There is no interaction between *condition* and *preceding rhyme* ($F(1,17) = 3.508$; $p = .078504$), however, the *p*-value is just above the 5% threshold (App. 11). Somewhat surprisingly, *condition* is significant ($F(1,17) = 9.221$; $p = .007503$). The estimated difference between the neutralised singleton and the neutralised geminate is 15 ms when preceded by a short vowel and 3 ms when preceded by a bipositional rhyme. These measurements are below or just within Lehiste's (1970: 13) 10–40 ms range of "just-noticeable difference". Payne (2005: 167) assumes a threshold of 25 ms, which would leave the neutralised stops indiscernible. I assume that the stops are "perceptually neutralized" (Slowiaczek & Szymanska 1989: 211). Future perception tests will have to shed further light on that matter.

Let us finally look at the four different contact possibilities for neutralisation. Fig. 36 gives an overview. On the left side are the results for the singletons. Those for the geminates are presented on the right. The labels on the x-axis read as follows: _geminate and _singleton refer to the following obstruent, geminate_ and singleton_ refer to the preceding obstruent. Examples are provided in Table 27.

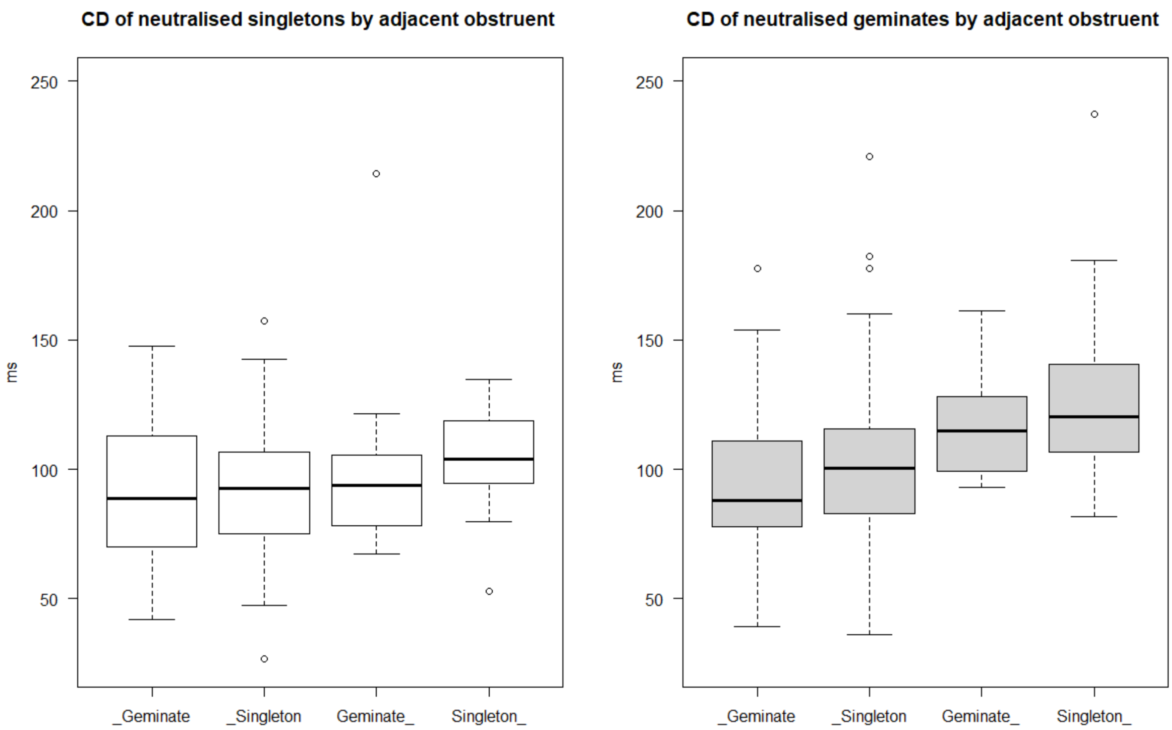


Fig. 36: CD of neutralised labial singleton and geminate stops by underlying category of the adjacent obstruent

Fig. 36 illustrates that all neutralised stops gather around 100 ms. A comparison of the two graphics shows that in an identical environment, singletons are shorter than geminates. Furthermore, neutralised stops are longer word-initially.[251] The mean values and geminate-singleton ratios are provided in Table 27.

	p	pː	ratio pː / p	mean difference pː - p	examples	
word-initial	**100.22**	**120.60**	**1.20**	**20.38**		
Geminate_	96.33	115.40	1.20	19.07	tə ʃtrɒfː **p**ɒsː	tə ʃtrɒfː **pː**ɒsː
Singleton_	103.80	125.79	1.21	21.99	sæk **p**ɒsː	sæk **pː**ɒsː
word-medial	**91.54**	**95.10**	**1.04**	**3.57**		
_Geminate	84.30	86.83	1.03	2.53	ʃɒ**p**tː	ʃnɒ**pː**tː
_Singleton	98.77	103.38	1.05	4.61	ʃɒ**p**ʃ	ʃnɒ**pː**ʃ
word-final	**93.02**	**101.76**	**1.09**	**8.74**		
_Geminate	97.59	103.16	1.06	5.57	sno**p** kːɛː	ʃto**pː** kːɛː
_Singleton	90.40	101.06	1.12	10.66	sno**p** kitː	ʃto**pː** kit
mean	**94.51**	**105.24**	**1.11**	**10.73**		

Table 27: Mean CD (in ms) for neutralised singleton and geminate stops according to the underlying category of the adjacent obstruent and position within the word

The ratios between the neutralised categories are highest word-initially. However, the neutralised stops are all below the perception threshold of 25 ms proposed by Payne (2005: 167). We may thus assume that they are not perceptually accessible, that is, that they are not recognised consciously. As for the neutralisation of coda obstruents, the ratios are virtually equal. Thus, the claim that any combination of singleton and geminate obstruents leads to the same “half-fortis” value can be confirmed. The boxplots below (Fig. 37) again visualise the CDs of the neutralised stops by the environment.

[251] The outlier in the left plot is an instance where the speaker (01) attempted to pronounce the initial neutralised geminate most clearly. In the sentence [sæk pːɒsː] ‘say passport’, she held the closure exceptionally long. The outcome, however, does not sound particularly marked, which is why it is included in the calculation.

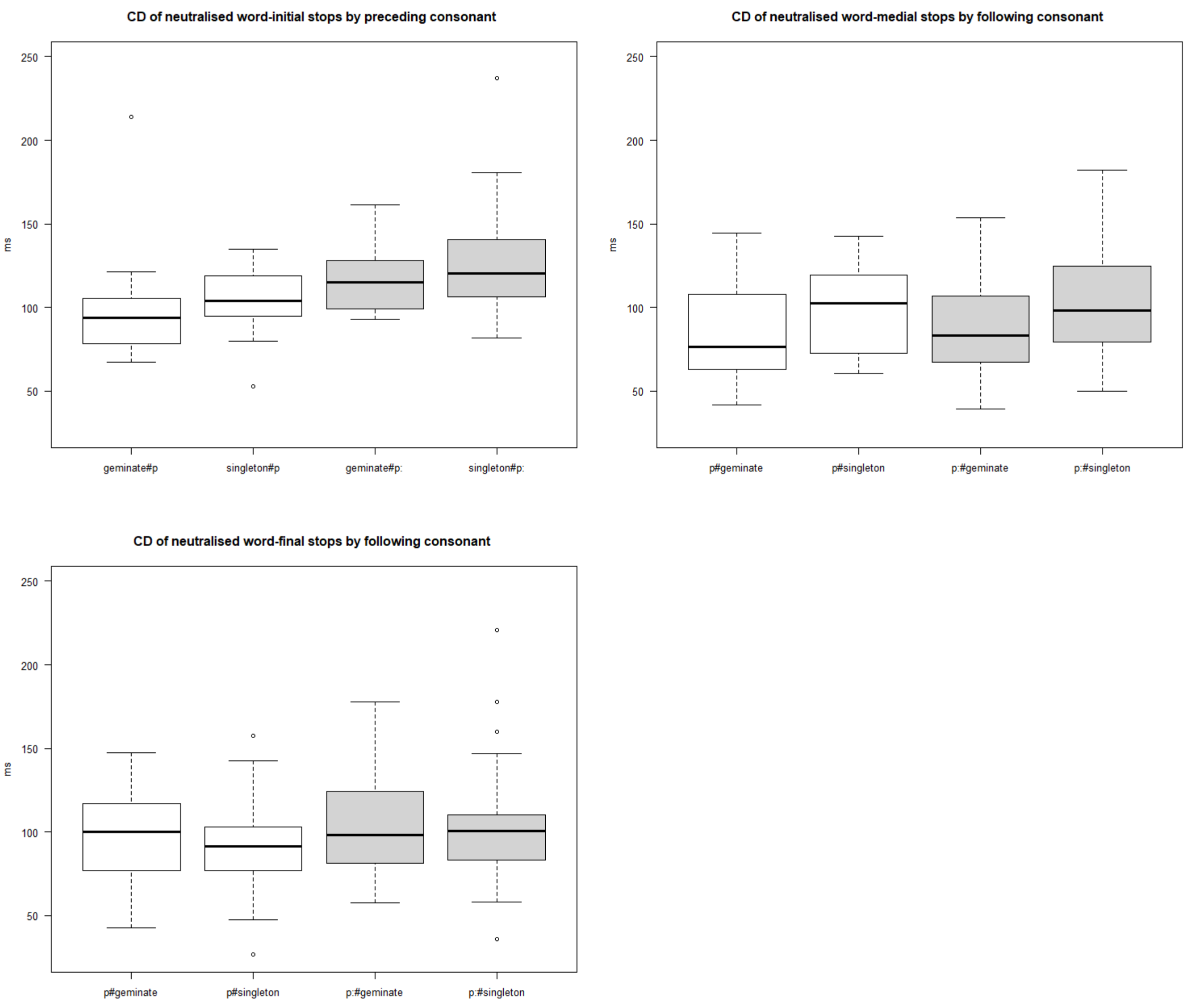


Fig. 37: Plots according to the position within the word for CD of neutralised singleton and geminate stops

To complete the picture, Fig. 38 shows the durations according to the preceding rhymes.[252] It reveals that neutralised stops are longer when preceded by a short vowel. Examples are given in Table 28.

[252] Note that the results only refer to the subset of phrase-medial stops, as there are no word-internal neutralised onsets in the corpus. This is not to say that word-internal neutralised onsets do not exist: In simplex words such as /optik͡x/ 'optics', the second member of the obstruent clusters normally is a coronal. As there are no alternations, it is impossible to tell the underlying category. Neutralised onsets also occur in morphologically complex words, e.g. /ʃluːxpoːtː/ 'rubber boat', /unʃlɒkpɒːr/ 'unbeatable'. Here, the underlying category can be retrieved.

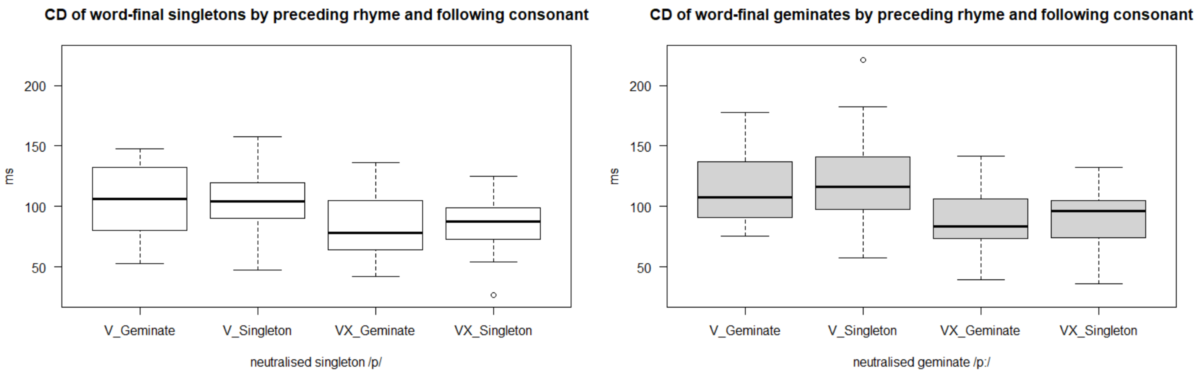


Fig. 38: Plots according to the preceding rhyme for CD of neutralised singleton and geminate stops

Table 28 shows that the ratio between singletons and geminates is virtually the same. The only notable exception is when the target stop is preceded by a short vowel and followed by a singleton obstruent. I have no explanation for this.[253]

	p	pː	ratio pː / p	mean difference pː - p	examples	
V	**103.19**	**118.87**	**1.15**	**15.68**		
_Geminate	103.48	113.63	1.10	10.14	sno**p** kːɛː	ʃto**pː** kːɛː
_Singleton	102.97	122.37	1.19	19.40	ʃɒ**p** sofortː	ʃnɒ**pː** sofortː
VX	**85.01**	**89.21**	**1.05**	**4.20**		
_Geminate	83.21	85.68	1.03	2.47	loː**p** kːɛː	kːoː**pː** kːɛː
_Singleton	86.21	91.56	1.06	5.35	loː**p** sofortː	huː**pː** sofortː
mean	**92.49**	**99.10**	**1.07**	**6.60**		

Table 28: Mean CD (in ms) for neutralised singleton and geminate stops according to the underlying category of the adjacent obstruent and the preceding rhyme

For statistical analysis, the four possible environments were set as modalities for a fixed effect "adjacent-C", (156):

(156)	Variable	levels	target consonant
	adjacent-C	_Geminate	singleton or geminate stop preceding a geminate
		_Singleton	singleton or geminate stop preceding a singleton
		Geminate_	singleton or geminate stop preceded by a geminate
		Singleton_	singleton or geminate stop preceded by a singleton

253 These findings seem to confirm Kraehenmann's assumption that the contrast is maintained after a short vowel (see 5.2.3). However, this is only half true, as Kraehenmann's predictions are independent of the following category. She thus cannot explain why neutralisation occurs when a geminate follows.

As expected, there was no main effect for *category,* yet we find a main effect for *preceding rhyme*. The two factors do not interact in a significant way (App. 12). Pairwise comparisons showed no significant differences, cf. Table 29:

Contrast	estimate	SE	df	t.ratio	p.value
_Geminate - _Singleton	4.23	3.47	278	1.22	0.6158
Geminate - Geminate	-7.62	11.17	19	-0.68	0.9024
Geminate - Singleton	-16.31	11.15	19	-1.46	0.4781
Singleton - Geminate	-11.85	11.04	19	-1.07	0.7096
Singleton - Singleton	-20.54	11.03	18	-1.86	0.2775
Geminate_ - Singleton_	-8.69	4.18	313	-2.08	0.1627

Table 29: Pairwise comparison of the estimated marginal means (in ms) among the four possible contact combinations for Heusler’s Law

Before we proceed, let us briefly sum up the essential findings:

- Neutralised singleton and geminate stops have “in-between” closure durations: compared to the non-neutralised counterparts, neutralised singletons are longer, and neutralised geminates are shorter. Neutralisation occurs in all four logically possible combinations. There are no significant differences.
  - The CD of neutralised stops is influenced by
    - The make-up of the preceding syllable:
      There is a significant main effect for the preceding rhyme: neutralised stops after bipositional rhymes are shorter than after monopositional rhymes. In contrast to the non-neutralised stops, the singletons are also affected. There is no interaction between *condition* and *preceding rhyme*. The statistical analysis also reveals significance for *condition*. However, the actual measurements are below a threshold of 25 ms (Payne 2005: 167). I assume that the difference is not perceived by the hearers.
    - The position within the word (word-medial vs at word edge) is not significant.

6.3.2. Fricatives

This section presents the results of the fricatives. The data are again restricted to labial instances. They all occur in (phrase-)medial position.

The dataset contains a total of 455 items, 196 of which are singletons, and 259 are geminates.[254] Recall from 2.3.1 that a) monosyllabic content words ending in singleton [f] preceded by a short vowel do not exist, and that b) word-initial fricatives are always singletons. The empty cells in Table 30 reflect the defective distribution. An overall statistical comparison of the data with regard to the parameter *preceding rhyme* as well as *word position* is thus not possible. An overview is given in Table 30.

			neutralised		non-neutralised	
			singleton	geminate	singleton	geminate
			77	120	119	139
position in word	word-internal ('within')		15	48	31	45
	word edge ('between')[255]	word-final	39	72	48	94
		word-initial	23	–	40	–
preceding rhyme[256]	monopositional ('V')		–	40	15	46
	bipositional ('VX')		54	80	104	93

Table 30: Number and distribution of the fricatives according to linguistic factors

6.3.2.1. Segment duration

A global picture of the durational differences between singleton, geminate, and neutralised fricatives is given in Fig. 39. As expected, neutralised fricatives are of

[254] One word which was initially in the corpus – [ʃyːrfət] 'scratch (1.pl.)' – was pronounced with a long fricative by three of the informants. The categorical status apparently varies for that particular item. All 48 instances that contain the verb stem *schürf* were removed from the analysis.

[255] In phrase-medial contexts.

[256] 23 word-initial items are set NA ("not applicable") for this parameter as they are preceded by an obstruent.

intermediate duration. However, the difference between neutralised and non-neutralised singletons is rather small. Furthermore, neutralised geminates are again longer than the singleton counterparts.

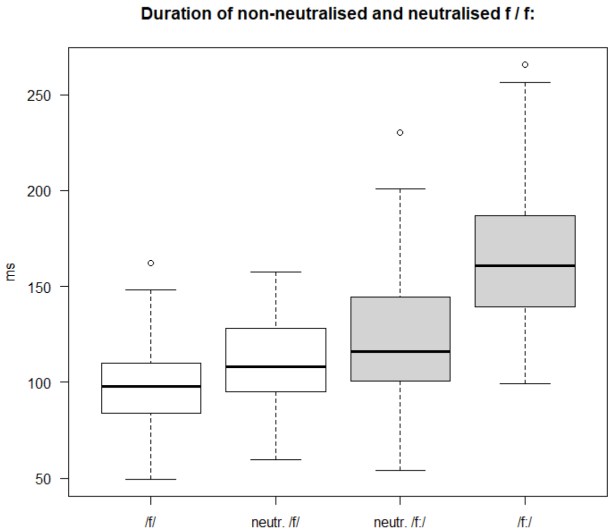


Fig. 39: Duration of non-neutralised and neutralised singleton (white) and geminate (grey) labial fricatives

Fig. 40 shows the individual plots for the eight speakers. For all speakers, the geminates have the longest duration. In most cases, the singletons are shortest, and the neutralised fricatives fall somewhere in between. The pattern is not so clear, however. In particular, two speakers (02 and 08) have considerable differences between neutralised singletons and neutralised geminates.

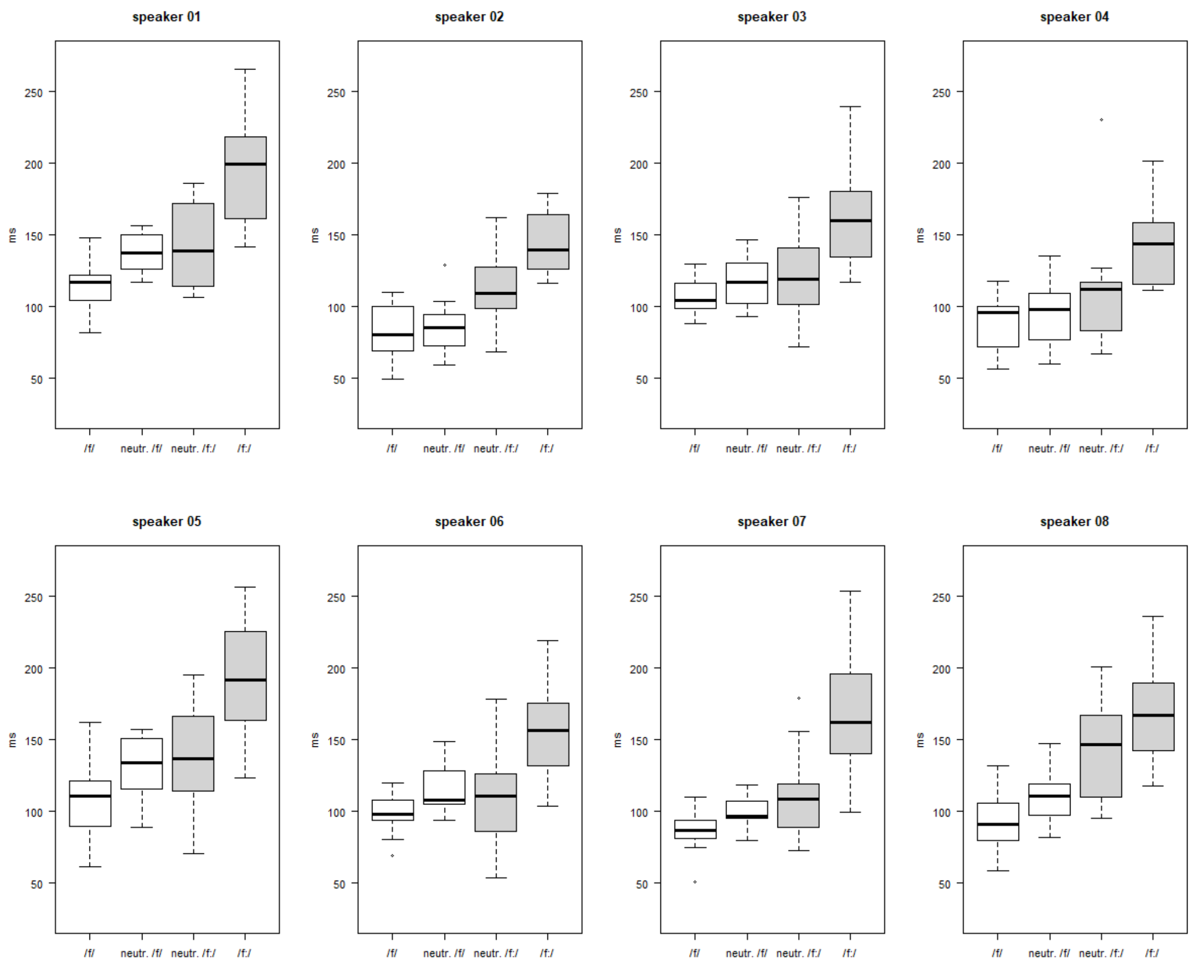


Fig. 40: Individual plots for the duration of non-neutralised and neutralised singletons (white), and neutralised and non-neutralised geminate (grey) labial fricatives

Pairwise comparisons between the four conditions reveal that only the comparison between the two neutralised conditions shows no significance. The difference between the remaining pairs is significant or highly significant. The results are summarised in Table 31.

Contrast	estimate	SE	df	t.ratio	p.value
singleton – neutralised singleton	-18.54	3.64	428	-5.10	<.0001
singleton – neutralised geminate	-37.98	10.56	29	-3.60	0.0062
singleton – geminate	-62.65	10.53	28	-5.95	<.0001
neutralised singleton – neutralised geminate	-19.44	10.72	30	-1.81	0.29
neutralised singleton – geminate	-44.11	10.69	30	-4.13	0.0015
neutralised geminate – geminate	-24.67	3.40	437	-7.25	<.0001

Table 31: Pairwise comparison of the estimated marginal means for segment duration (in ms) among the conditions *singleton, neutralised singleton, neutralised geminate,* and *geminate*

As mentioned above, the lack of neutralised singletons preceded by a short vowel makes it impossible to analyse neutralisation with respect to the preceding environment.[257] For the non-neutralised items, however, an investigation is possible. In order to analyse the non-neutralised instances, the data were subsequently divided into two subsets, containing the neutralised and the non-neutralised data, respectively. The results of the non-neutralised, i.e. intersonorant, fricatives are reported in the subsection below.

6.3.2.2. Intersonorant /f/ and /fː/

In intersonorant position, singleton and geminate fricatives are contrastive. The opposition is supposed to hold in phrase-medial contexts, too. Fig. 41 below shows the overall durations of non-neutralised singletons and geminates. It reveals that the average segment duration of intersonorant geminate labial fricatives is more than 1.5 times longer than the duration of the singleton.

[257] In his investigation on neutralised fricatives, Schmid (2008) used carrier sentences containing function words such as [uf] 'on'. I deliberately did not include function words in order to keep the prosodic environment constant.

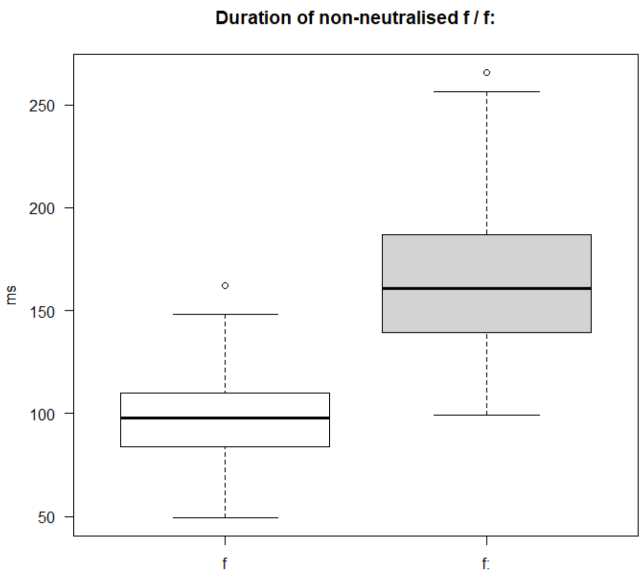


Fig. 41: Overall duration of intersonorant singleton and geminate labial fricatives

Despite considerable inter-speaker variation, geminates are consistently longer. The boxplots in Fig. 42 give a clear visual impression. Note that the boxes never overlap.

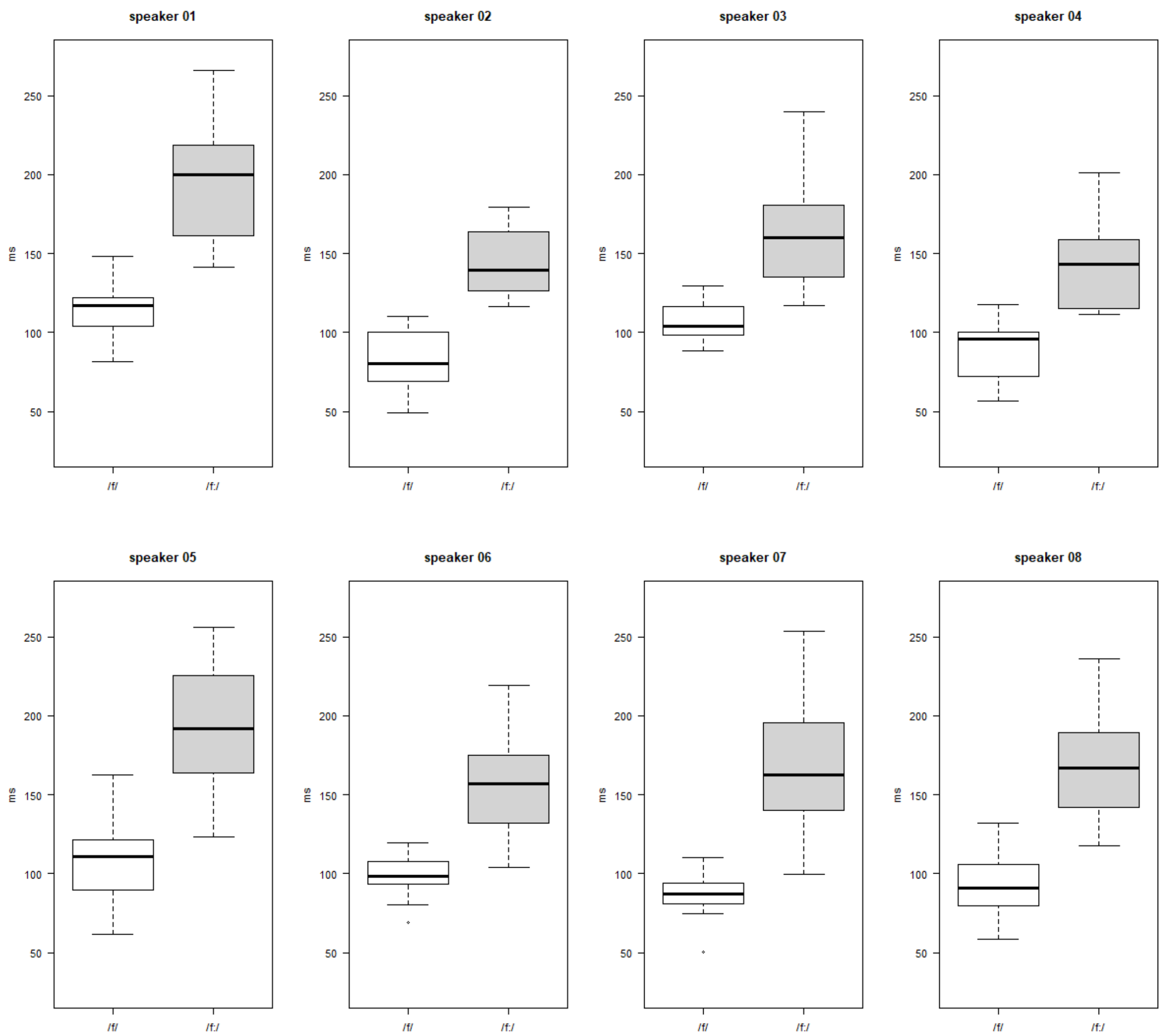


Fig. 42: Overall duration of intersonorant singleton and geminate labial fricatives by speaker

This is again shown in Table 32, where the average durations are presented by speaker. With a ratio ranging from 1.5 up to almost 2, there is less inter-subject variability than with the stops.

Speaker	mean singleton /f/	mean geminate /fː/	Ratio gem : sing
01	115.57	195.31	1.69
02	82.86	143.88	1.74
03	106.82	162.04	1.52
04	87.54	142.86	1.63
05	107.83	192.43	1.78
06	98.24	153.92	1.57
07	86.73	169.65	1.96
08	91.91	168.63	1.83
mean	97.03	165.93	1.71

Table 32: Duration (in ms) of intersonorant singleton and geminate labial fricatives and ratio by speaker

The factors that are likely to influence the duration are again the position of the fricative within the word and the make-up of the preceding rhyme. If there are no significant differences between intersonorant fricatives that occur word-medially and those at the word edge, this would substantiate the assertion that ZG syllabifies across word boundaries. Durational differences with respect to the rhymal shape call for closer scrutiny: if there is an interaction between singletons and geminates, this may indicate the heterosyllabic nature of geminates. Whereas singletons remain unaffected by the structure of the preceding rhyme because they are entirely syllabified in the following onset, the preceding rhyme could have an effect on geminates. Table 33 gives an overview of the two parameters under investigation.

		V_	SD	VX_	SD	ratio V_ : VX_
f	word-medial	116.83	22.39	105.56	18.72	1.11
	word edge	98.61	22.26	92.59	20.23	1.07
fː	word-medial	210.24	33.15	181.57	35.69	1.16
	word edge	174.01	31.11	143.96	28.40	1.21

Table 33: Mean duration (in ms), standard deviation (SD) and ratio for intersonorant singleton and geminate fricatives in word-medial and word edge position preceded by a monopositional (V) or bipositional (VX) rhyme

As can be seen from Table 33, fricatives are longer word-medially than at the word edge. Furthermore, singleton and geminate fricatives are longer when preceded by a short vowel. Ratios range between 1.1 and 1.2. The durational differences are less pronounced for singletons.

The durations of singletons and geminates within and across words are shown in Fig. 43.

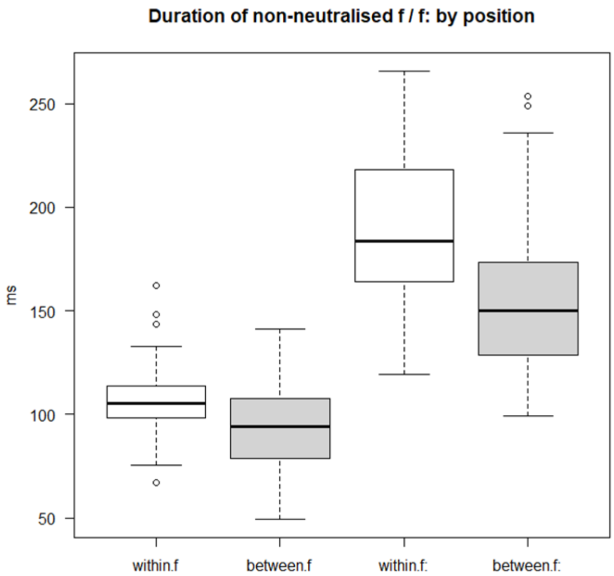


Fig. 43: Duration of intersonorant singleton and geminate labial fricatives according to the position within the word (‘within’ = word-internal, ‘between’ = at word edge, i.e., straddling a word boundary)

From the data in Fig. 43, it is apparent that word-medial fricatives are longer than those at a word boundary. Statistical analysis revealed significant main effects for *condition* ($F(1,19) = 78.12$, $p < .0001$) and for *position* ($F(1,16) = 14.75$, $p = .001413$). The interaction is not significant ($F(1,16) = 3.10$, $p = .097102$), cf. App. 13.

The geminate-singleton ratios in word-medial and phrase-medial instances are given in Table 34. Phrase-medial data have been divided into instances where the target consonant is word-final (e.g. ʃnuːf əmɒːl ‘breathe once (imp.sg.)’) and instances where it is word-initial (e.g. tə fiʃː ‘the fish’). Geminates do not occur word-initially. As seen above, the duration of word-medial singleton fricatives is longer compared to instances at word edges. This is particularly obvious for word-initial fricatives. The ratios show that for all speakers, word-medial intersonorant geminates are about 1.7 times longer than their singleton counterparts. Singletons and geminates are longest in word-medial position; however, the contrast is clearly maintained phrase-medially, too.

	mean duration [f]	mean duration [fː]	Ratio gem : sing
word-medial	108.11	191.13	1.77
phrase-medial, word-final	96.54	153.87	1.59
phrase-medial, word-initial	89.05		

Table 34: Mean duration (in ms) and ratio of intersonorant labial fricatives in word-medial position and across word boundaries

Intersonorant singletons and geminates differ in duration irrespective of the rhymal make-up of the preceding syllable. Fig. 44 shows that geminates are shorter after long vowels than after short vowels. Statistical analysis proves both, *condition* and *preceding rhyme,* to have significant main effects ($F(1,23) = 49.55$, $p < .0001$, and $F(1,31) = 9.23$, $p = .004793$). There is no significant interaction between the two factors ($F(1,31) = 1.459$, $p = .236225$), cf. App. 14.[258]

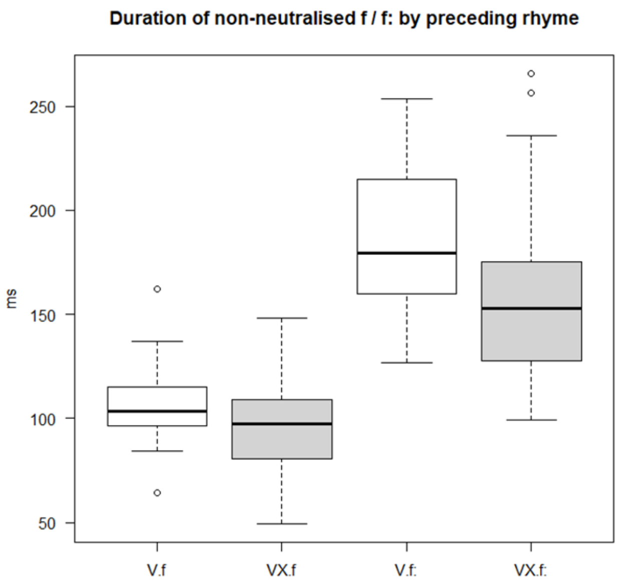


Fig. 44: Duration of intersonorant singleton and geminate labial fricatives preceded by monopositional (V) or bipositional (VX) rhyme

Before we proceed to the neutralised fricatives, let us briefly summarise the results.

- Intersonorant (non-neutralised) singleton and geminate fricatives differ significantly in segment duration. The overall ratio is 1:1.7.
  - The duration of non-neutralised fricatives is influenced by
    - The fricative's position within the word (word-medial vs at word edge): Both singletons and geminates are longer word-medially than across the word boundary. There are no interactions.

[258] Note that for lack of word-final singleton fricatives after a short vowel in the corpus, only word-medial instances of singletons preceded by monopositional rhymes (e.g., hɒfə 'harbour') entered statistical analysis.

– The make-up of the preceding syllable (monopositional vs bipositional): Both singletons and geminates are longer if they are preceded by a monopositional rhyme. Geminates are more affected by the rhymal environment than singletons; however, there are no interactions.

6.3.2.3. Neutralised /f/ and /fː/

The overall distribution of neutralised fricatives is given in Fig. 45. While the boxes are kept distinct for the intersonorant examples (cf. Fig. 41), the neutralisation data overlap.

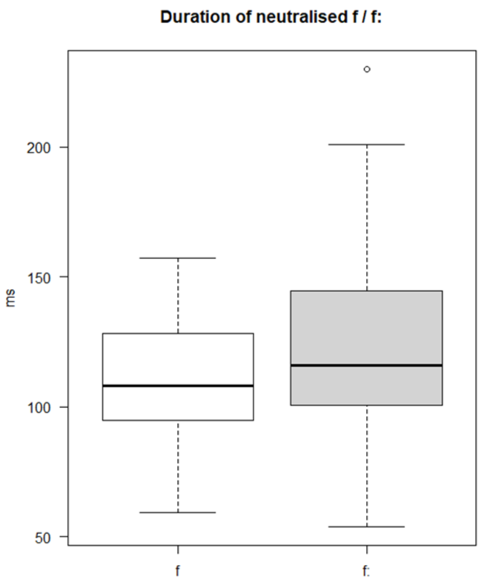


Fig. 45: Overall duration of neutralised singleton and geminate labial fricatives

The by-subject plots are given in Fig. 46. Apart from the speakers 02 and 08, we find a clear overlap of the boxes of neutralised singleton and geminate fricatives.

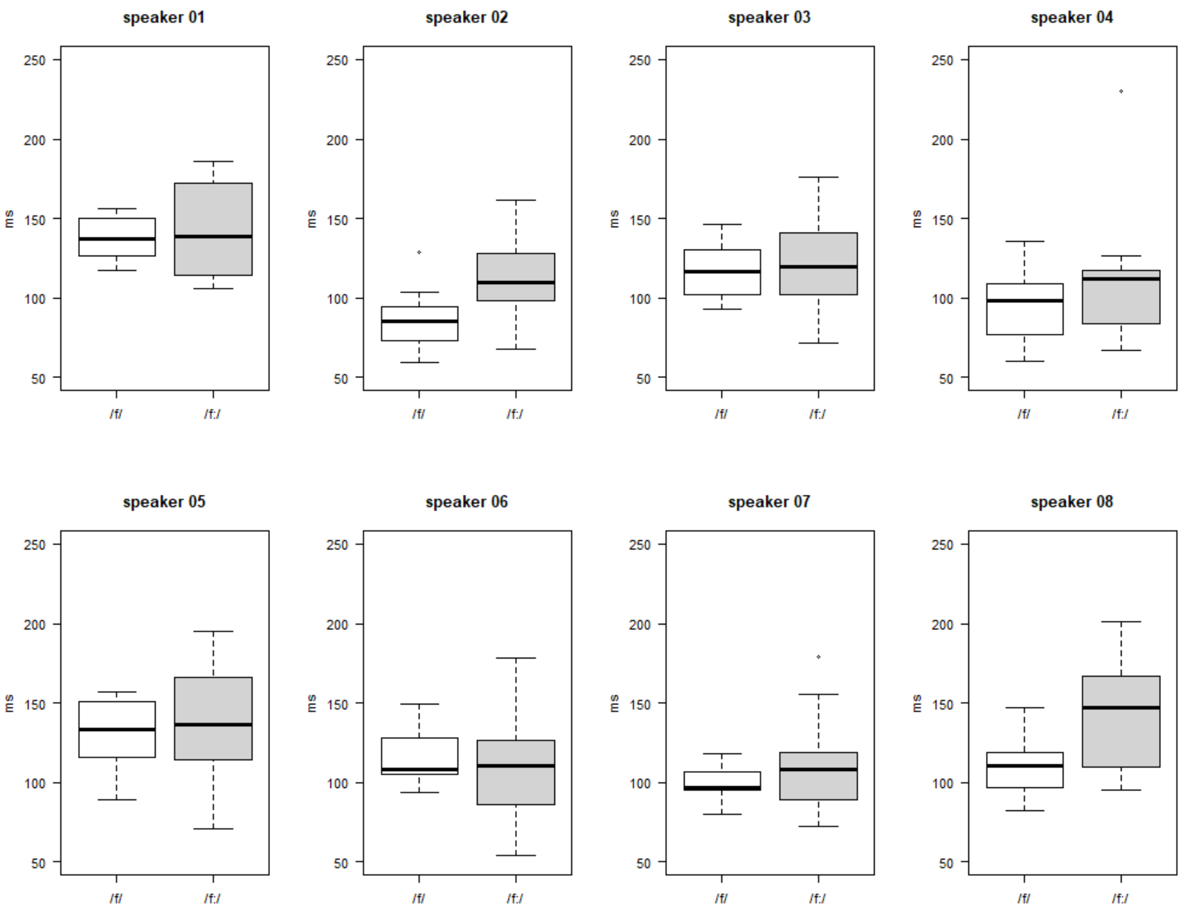


Fig. 46: Individual plots for the duration of neutralised singleton and geminate labial fricatives

Table 35 provides the mean values for neutralised and non-neutralised fricatives by speaker. Compared to the non-neutralised means, the neutralised are again of intermediate duration. This also holds for speaker 08 and, to a far lesser extent, even for 02. For comparison, the respective non-neutralised values are given in brackets.

Speaker	mean singleton /f/		mean geminate /fː/		Ratio gem : sing	
01	137.54	(115.57)	140.67	(195.31)	1.02	(1.69)
02	86.40	(82.86)	110.63	(143.88)	1.28	(1.74)
03	116.10	(106.82)	121.50	(162.04)	1.05	(1.52)
04	96.92	(87.54)	109.88	(142.86)	1.13	(1.63)
05	129.99	(107.83)	138.06	(192.43)	1.06	(1.78)
06	114.31	(98.24)	107.59	(153.92)	0.94	(1.57)
07	99.29	(86.73)	109.85	(169.65)	1.11	(1.96)
08	109.62	(91.91)	143.40	(168.63)	1.31	(1.83)
mean duration	110.74	(97.03)	122.70	(165.93)	1.11	(1.71)

Table 35: Mean duration (in ms) for neutralised singleton and geminate fricatives and ratio by speaker (the corresponding durations of the non-neutralised fricatives are in brackets)

According to Heusler's Law, neutralisation appears within words (e.g. ʃtrɒːfːʃ 'punish (2.sg.)') and across word boundaries (e.g. ʃtrɒːfː sofortː 'punish (imp.sg.) at once'). However, the position within the word affects the duration of the consonant. As shown in Fig. 47, neutralised fricatives are shorter word-medially than at word edge.

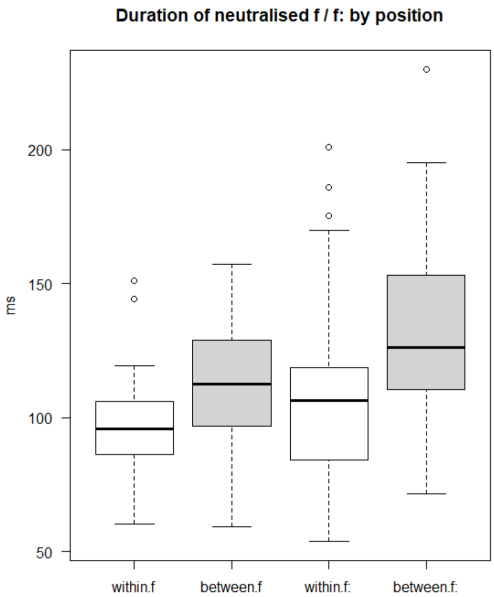


Fig. 47: Duration of neutralised singleton and geminate labial fricatives by position within the word ('within' = word-internal, 'between' = at word edge, i.e., straddling a word boundary)

Statistically, neither *condition* nor the *position* within word are significant main effects ($F(1,16) = 1.55$, $p = .2305$, and $F(1,14) = 2.46$, $p = .1389$). The factors do not significantly interact, either, cf. App. 15.[259]

Fig. 48 shows the duration according to the preceding rhyme. As mentioned before, the data set is deficient, because singleton fricatives preceded by a monopositional rhyme are missing. Statistical analysis is therefore not possible. For the neutralised geminate, however, we can state that it is longer when preceded by a monopositional rhyme.[260]

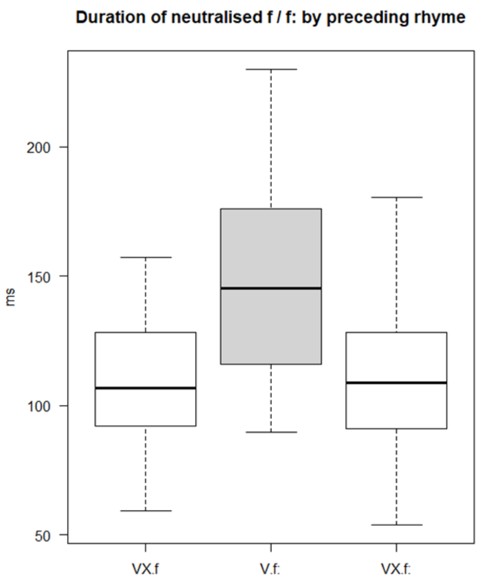


Fig. 48: Duration of neutralised singleton and geminate labial fricatives preceded by monopositional (V) or bipositional (VX) rhyme

Lastly, let us look at the four different contact possibilities for neutralisation. Fig. 49 gives an overview. The plot on the right shows word-initial instances. They are all singletons, followed by either a geminate ('_Geminate') or a singleton ('_Singleton'). The plot on the left gives the duration of instances in word-medial or word-final position followed by an obstruent.

259 Since ZG has a bimoraic minimum on content words, there are no comparable data with word-final singleton fricatives preceded by a short vowel. For stops, imperative forms and inflectional forms such as *schabsch* [ʃɒpʃ] 'scratch (2.sg.)' were used to test neutralisation. As verb stems with a short vowel that end in a singleton labial fricative do not exist, the singleton exponent in the "between" data in Fig. 47 is limited to either word-final instances preceded by a bipositional rhyme or word-initial instances preceded by an obstruent.

260 As there are no instances where a singleton fricative is preceded by a short vowel and followed by another obstruent, the model estimated a linear intercept based on the values for the geminate. Here, we find a main effect for preceding rhyme ($F(1,15) = 16.1063$, $p = .00117$). Due to the missing data, no interactions could be calculated.

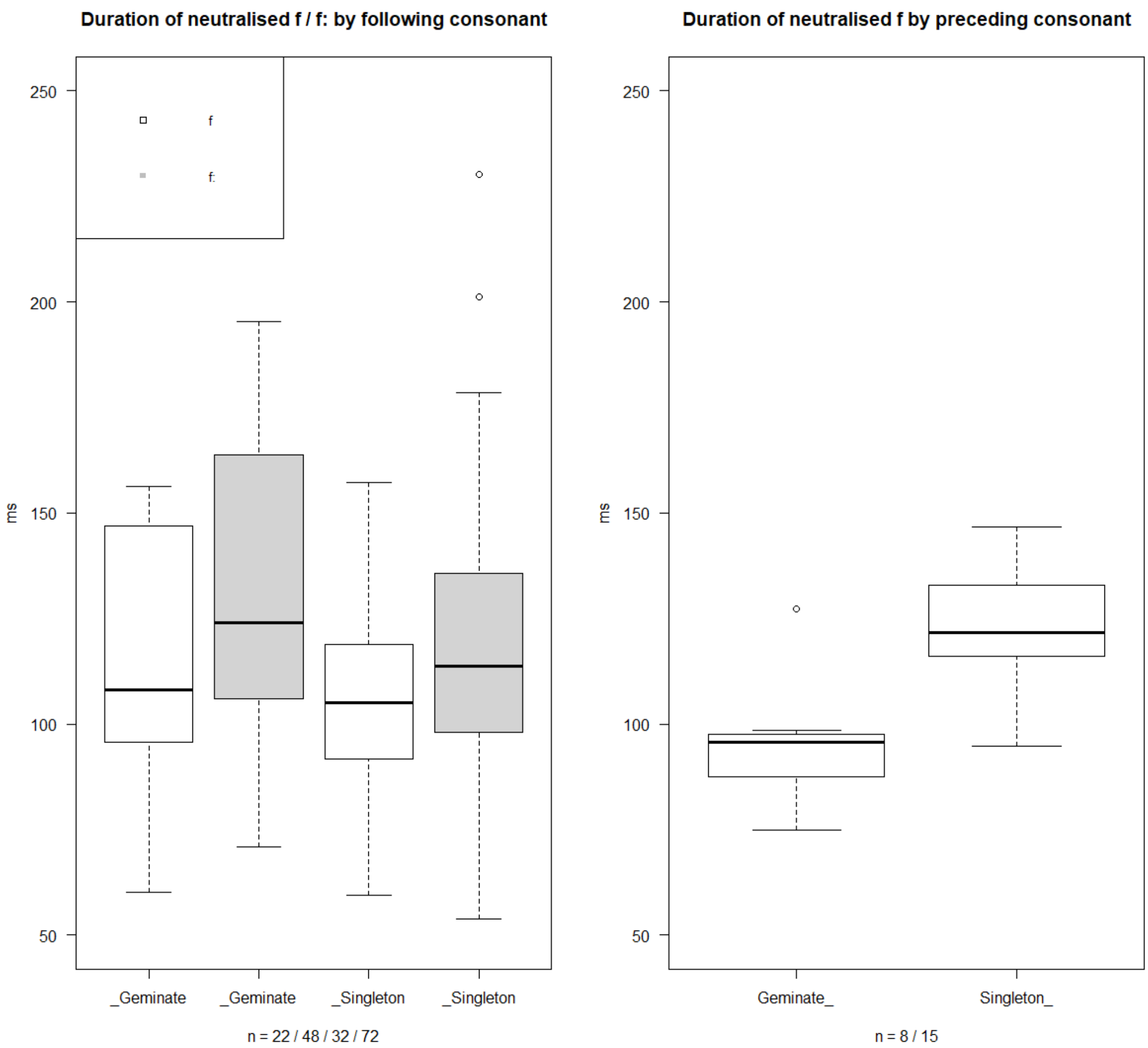


Fig. 49: Duration of neutralised singleton and geminate labial fricatives by underlying category of the adjacent obstruent ('_Geminate' / '_Singleton' = following obstruents; 'Geminate_' / 'Singleton_' = preceding obstruents)

The database is too small to draw any conclusions for word-initial fricatives. However, the left plot in Fig. 49 reveals that geminate fricatives are somewhat longer irrespective of whether they are followed by a singleton or a geminate obstruent. The average durations for the three positions within the word are shown in Table 36.

	f	fː	ratio fː / f	mean difference fː - f	example	
word-initial	**113.92**					
Geminate_	95.49				tə krosː fiʃː	
Singleton_	123.75				sæk fiʃː	
word-medial	**99.21**	**109.52**	**1.10**	**10.31**		
_Geminate	95.53	118.49	1.24	22.96	ʃnuːftː	ʃtrɒːfːtː
_Singleton	102.44	100.55	0.98	-1.89	ʃnuːfʃ	ʃrɒːfːʃ
word-final	**113.31**	**131.48**	**1.16**	**18.18**		
_Geminate	124.07	145.45	1.17	21.38	koːf kːɛː	ʃtrɒːfː kːɛː
_Singleton	106.58	124.50	1.17	17.92	koːf kitː	ʃtrɒːfː kit
mean	**110.74**	**122.70**	**1.11**	**11.95**		

Table 36: Mean duration (in ms) for neutralised singleton and geminate fricatives by the underlying category of the adjacent obstruent and position within the word

Table 36 shows that the fː/f ratio ranges up to 1:1.24 and the mean difference between singleton and geminate in a particular environment reaches over 20 ms. It is somewhat puzzling that the differences in duration are not perceived. According to Heusler's Law and subsequent linguistic descriptions, however, the contrast is neutralised even though acoustically measurable.

Again, let us sum up the findings for fricatives:

– Intersonorant (non-neutralised) singleton and geminate fricatives differ significantly in segment duration. The overall ratio is 1:1.7.
  – The duration of non-neutralised fricatives is influenced by
    – The fricative's position within the word (word-medial vs at word edge): Both singletons and geminates are longer word-medially than across the word boundary. There are no interactions.
    – The make-up of the preceding syllable (monopositional vs bipositional): Both singletons and geminates are longer if they are preceded by a monopositional rhyme. Geminates are more affected by the rhymal environment than singletons; however, there are no interactions.

- Neutralised singleton and geminate fricatives do not significantly differ in duration. The overall ratio is 1:1.1.
  - The duration of neutralised fricatives is influenced by
    - The make-up of the preceding syllable (monopositional vs bipositional): Geminates are longer after monopositional rhymes (no statements can be made about singletons, due to missing data)
    - The position within the word (word-medial vs at word edge) is not significant

6.3.3. Summary Heusler's Law

The measurements presented in the previous sections show that in intersonorant position, ZG singleton and geminate obstruents do contrast. The contrast is upheld in any intersonorant position, be it word-medially or at word edges. Geminates are longer than singletons irrespective of the make-up of the preceding rhyme. They are, however, longest when preceded by a short vowel.

According to Heusler's Law, the singleton/geminate contrast is neutralised when two obstruents occur in adjacent position. As pointed out in Section 2.4.3, the resulting sound has been referred to as 'half-fortis' or 'semi-fortis'. The general impression thus apparently was that they were *fortis*-like, rather than *lenis*-like. In terms of a durational contrast, this could be translated to "longer than a normal *lenis* but not as long as a normal *fortis*".

The measurements of the neutralised obstruents corroborate this claim. Table 37 provides a summary. For convenience, the corresponding values in a contrasting environment are added in brackets.

	neutralised singleton		neutralised geminate	
mean CD labial stop	94.51	(62.63)	105.24	(132.58)
mean duration labial fricative	110.74	(97.03)	122.70	(165.93)

Table 37: Mean duration (in ms) of neutralised and non-neutralised labial stops and fricatives

Compared to the mean duration in a contrasting environment, the duration of the neutralised obstruents is indeed in-between. However, there are differences. The duration of the neutralised obstruent depends on the position in the word as well as on the structure of the preceding rhyme. These effects are especially noticeable for geminate stops. The neutralisation in an intermediate value takes place in all four possible contact combinations. However, differences are measurable here, as well.

We are thus faced with the situation that the neutralised consonants differ, but hearers apparently do not perceive this difference. Assuming that differences below 25 ms are imperceptible would explain our "deafness" to more subtle durational variances.

One should keep in mind that Moraic Theory is about contrasts and not about the exact phonetic characteristics of a segment. Although the neutralised values do not match either the singletons or the geminates, they are non-contrastive. Heusler's Law thus indeed yields a "third value" in the sense of Trubetzkoy (cf. 5.1.1).

Nevertheless, let us now ask how Moraic Theory deals with these "intermediate values". Moraic Theory has no means for a three-way contrast: Segments are either moraic or not. This is unproblematic as there is no evidence for a three-way contrast in ZG. However, as laid out previously, Moraic Theory provides three structures: moraless segments, segments that are associated with a mora, and multiply linked segments. The first corresponds to the singletons in intersonorant contexts. The third corresponds to the geminates in intersonorant contexts. Moraic elements that do not have a "flopping structure" are either inherently moraic segments followed by an obstruent, or singletons which are assigned a mora via WbP. This means that Moraic Theory permits two kinds of moraic consonants: singly linked and multiply linked. Phonetically, they differ as multiply linked structures are interpreted as longer; however, phonologically they pattern alike.

Inherently moraic segments, therefore, exhibit an allophonic distribution: if they are associated with the subsequent onset due to Onset Maximization, they appear as heterosyllabic geminates. If Onset Maximization is not possible, they are still longer than nonmoraic segments, but not as long as in an intersonorant context. This is, in essence, in accordance with proposals by Haas (1978) and Weber (1948).

Singletons are moraic when they are assigned a structural mora by WbP. That is, the contrast between inherently moraic segments and singletons is neutralised in coda position after a monopositional rhyme. For stops, this prediction has been borne out, cf. Fig. 35. No definitive conclusion can be drawn for fricatives, as labial singletons do not occur after short vowels.

Heusler's Law, however, predicts neutralisation in all contact situations. It remains to be clarified why singletons after bipositional rhymes and in the onset are longer than in intersonorant context. Moraic Theory offers no straightforward answer. Perhaps coda consonants are longer because they are adjoined to a mora. Broselow et al. (1995) have shown for Malayalam that mora adjunction significantly affects the length of a coda consonant. In the case of initial singletons, it has been reported for a number of languages that in heterosyllabic CC clusters, the second consonant is strengthened in order to make it more prominent (e.g. Steriade 1997, 1999).

A second case where alternations in consonant length occur is described by Winteler's Law, which is explained in more detail in the following sections. It concerns lengthening processes of sonorant consonants. Unlike Heusler's Law, Winteler's Law only affects coda consonants. If Winteler's Law has an empirical basis, it would be additional evidence for the reality of positional neutralisation.

6.3.4. Sonorants

Winteler's Law states a longer duration for syllable-final sonorants preceded by a short vowel. The sonorants in (157)a) are thus supposedly longer than those in (b), where the sonorant is syllable-initial, and those in (c), where the sonorant is preceded by a long vowel (or a vowel-sonorant cluster):

(157)	a.	[ʃʊɒlpə] 'swallow'	[fylʃ] 'fill (2.sg)'	[k͡xnɒl] 'bang'
	b.	[rolə] 'role'	[k͡xnɒlət] 'bang (1.pl.)'	[foːlə] 'foal'
	c.	[mɒːl] 'paint (imp.sg.)'	[hyːlʃ] 'cry (2.sg.)'	

The following study is limited to the alveolar and the labial nasal, as well as the lateral /l/. Rhotic /r/ and the velar nasal are excluded from the analysis. With respect to the former, Winteler (1876: 76f.) explicitly mentions the exceptional behaviour of /r/: it has no *fortis* counterpart and thus cannot participate in Winteler's Law. The velar nasal /ŋ/ was also excluded from further analysis as it has a restricted distribution (cf. 2.3.2.2).

Four linguistic factors were determined for the statistical evaluation and the data were coded accordingly. Table 38 gives an overview.

	variable	levels
linguistic factors	category	n m l
	prec_rhyme	V VX
	syllable position	Onset Coda
	word position	edge non-edge
extralinguistic factors	subject	
	item	

Table 38: Fixed and random effects for sonorants

The factor levels edge/non-edge determine whether the sonorant is in word-final position or elsewhere. Since the data were encoded according to the syllabification algorithm described in 4.4, word-final sonorants followed by a vowel-initial word phrase-medially are analysed as onsets.[261] (158) shows how *word position* and *syllable position* are cross-classified: Items specified for both *word position: edge* and *syllable position: Onset* are instances of postlexical syllabification. The specification *word position: non-edge* and *syllable position: Onset,* on the other hand, indexes word-medial onsets. Examples are provided in (158), where the sonorant in question is put in boldface.

(158)		word position	
		edge	non-edge
syllable position	Coda	ʃʊy**m** ‘swim (imp.sg.)’ ʃliː**m** ‘slime’	hi**l**fː ‘help’ ʃʊɒ**l**pə ‘swallow’
	Onset	ʃʊy**m** əmɒːl ‘swim at once! (imp.sg.)’	nɒ**m**ə ‘name’

Of a total of 780 items, 422 items match the structure where Winteler’s Law should apply. They are shaded in Table 39 below. Recall from 2.3.2.1, that word-medial sonorants followed by *-ər* are lengthened. They are excluded from the data set.

[261] As we shall see shortly, this assumption cannot be upheld without restrictions.

			l	m	n	total
Onset			**61**	**69**	**61**	**191**
	V		**31**	**30**	**30**	**91**
		edge	15	14	14	43
		non-edge	16	16	16	48
	VX		**30**	**39**	**31**	**100**
		edge	15	15	15	45
		non-edge	15	24	16	55
Coda			**282**	**162**	**145**	**589**
	V		**242**	**90**	**90**	**422**
		edge	24	24	24	72
		non-edge	218	66	66	350
	VX		**40**	**72**	**55**	**167**
		edge	24	24	23	71
		non-edge	16	48	32	96
total			**343**	**231**	**206**	**780**

Table 39: Overview of the sonorant consonants in the data set

If Winteler's Law has an empirical basis, we can make the following predictions:

1. Due to the fact that Winteler's Law only applies to coda sonorants preceded by a short vowel, we would expect an interaction between *preceding rhyme* (V / VX) and *syllable position* (Onset / Coda): the duration of the target consonant is affected by its position within the syllable as well as by its preceding environment in a non-linear way, since the preceding vowel quantity has no influence on onset consonants.
2. Winteler's Law is said to affect all sonorant consonants under investigation. Therefore, we do not expect category-specific behaviour.
3. Under the assumption that ZG syllabification operates across word-boundaries, effects for word position (edge / non-edge) are not expected.

Fig. 50 shows the overall duration of the sonorants separated by the factors *syllable position* (Coda / Onset) and *preceding rhyme* (V / VX).[262] The second plot from the right shows the instances that are subject to Winteler's Law. As expected, coda consonants are longer than those in the onset. The difference between coda

[262] Recall that phrase-medial word-final sonorants followed by a vowel-initial word are coded as onsets (e.g. mɒːl əmɒːl 'paint once').

consonants preceded by a short vowel compared to those that follow a long vowel or a vowel + sonorant cluster, however, is relatively small.

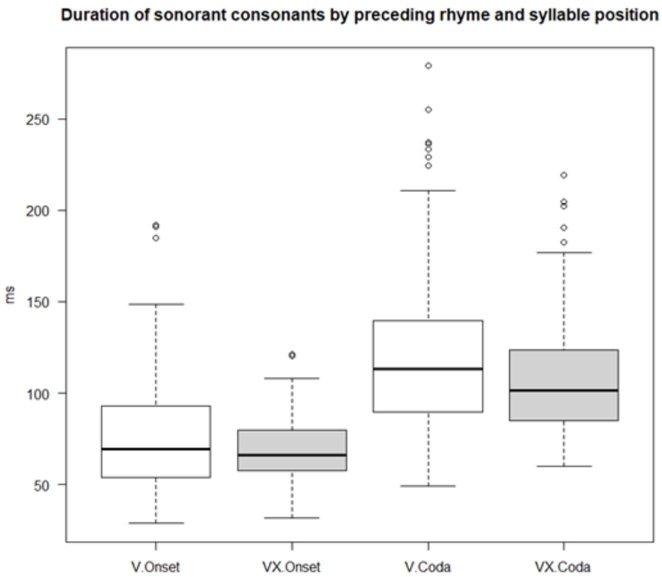


Fig. 50: Duration of sonorant consonants according to preceding rhyme and syllable position

Table 40 provides the average duration divided by the category. Compared to the nasals, the lateral is generally shorter. However, the overall pattern remains constant: Coda sonorants are longer than onset sonorants, and they are longest when preceded by a short vowel. The measurements thus conform to Winteler's initial impression. The ratios between coda and onset position are around 1.5, which indicates that coda consonants are noticeably longer than onsets. Coda consonants are also considerably longer when they are preceded by a bipositional rhyme. Note, however, that the durational difference of coda /l/ preceded by a short vowel or a long vowel is quite small. Contrariwise, the difference between onset /n/ in the two contexts is unexpectedly large.

		V	VX	mean difference	ratio Coda : Onset	
				V-VX	V	VX
l	Onset	66.78	59.54	7.24	1.55	1.59
	Coda	103.83	94.61	9.22		
m	Onset	83.30	79.56	3.74	1.63	1.37
	Coda	135.65	109.32	26.33		
n	Onset	89.20	64.25	24.95	1.54	1.77
	Coda	137.10	113.92	23.18		

Table 40: Average duration (in ms) and ratio of sonorant consonants preceded by V or VX in onset and coda position

Since the formulation of Winteler's Law restricts lengthening to coda sonorants after short vowels, coda sonorants after bipositional rhymes should be shorter than after monopositional rhymes. Furthermore, onsets are not expected to exhibit any durational differences.

For statistical analysis, the effects of *preceding rhyme, syllable position,* and *category* were evaluated on sonorant duration. There are significant main effects for *syllable position* ($F(1, 593) = 159.845$, $p < .0001$), and for *category* ($F(2, 64) = 7.571$, $p = .001120$), cf. App. 16.

The result is somewhat surprising. Since the preceding rhyme should only influence the duration of coda sonorants while leaving the onsets unaffected, we would expect an interaction between *preceding rhyme* and *syllable position.* However, the two factors do not interact significantly, suggesting that *preceding rhyme* influences the duration of onset and coda sonorants in a similar fashion: coda sonorants are generally longer than onset sonorants, irrespective of the nature of the rhyme preceding them.

There are no interactions for *category,* indicating that the relations between *preceding rhyme* and *syllable position* are the same for all three sonorants. They were, therefore, grouped together, and the actual category was not considered for further analysis.

In order to get a clearer picture, a fourth parameter, the position within the word, has been taken into account. As has been outlined in 4.4, ZG syllabification operates across word boundaries: word-final sonorants are resyllabified in the onset whenever a vowel-initial word follows. Therefore, we do not expect a durational difference between word-internal and word-crossing instances. The examples in (159) and (160) illustrate this. In (159), the sonorant is non-final. It is syllabified in the onset when it precedes a vowel (a), and in the coda when a consonant follows (b). In (160), the sonorant is final. In phrase-medial context, we expect it to be resyllabified in the onset whenever a vowel-initial word follows (a). If the following word begins with a consonant, the sonorant remains in the coda (b).

(159) a. rolə 'role'
fo:lə 'foal'
b. fylʃ 'fill (2.sg.)'
hy:lʃ 'cry (2.sg.)'

(160) a. k͡xnɒl əmɒːl 'bang once (imp.sg.)'
mɒːl əmɒːl 'paint once (imp.sg.)'
b. k͡xnɒl sofortː 'bang at once (imp.sg.)'
mɒːl sofortː 'paint at once (imp.sg.)'

The left graphic in Fig. 51 shows the duration of non-final (i.e., *non-edge*) sonorant consonants. The first two plots correspond to (159)a), and the third and the fourth plot correspond to (b). It is obvious that coda sonorants are consistently longer than onset sonorants. Furthermore, coda consonants preceded by a short vowel are slightly longer than those that are preceded by a bipositional rhyme.

Word-final sonorants within a syntactic context are shown in the right graphic. The first and second plot represent data such as (160)a), and the third and the fourth plot correspond to instances as described in (b).

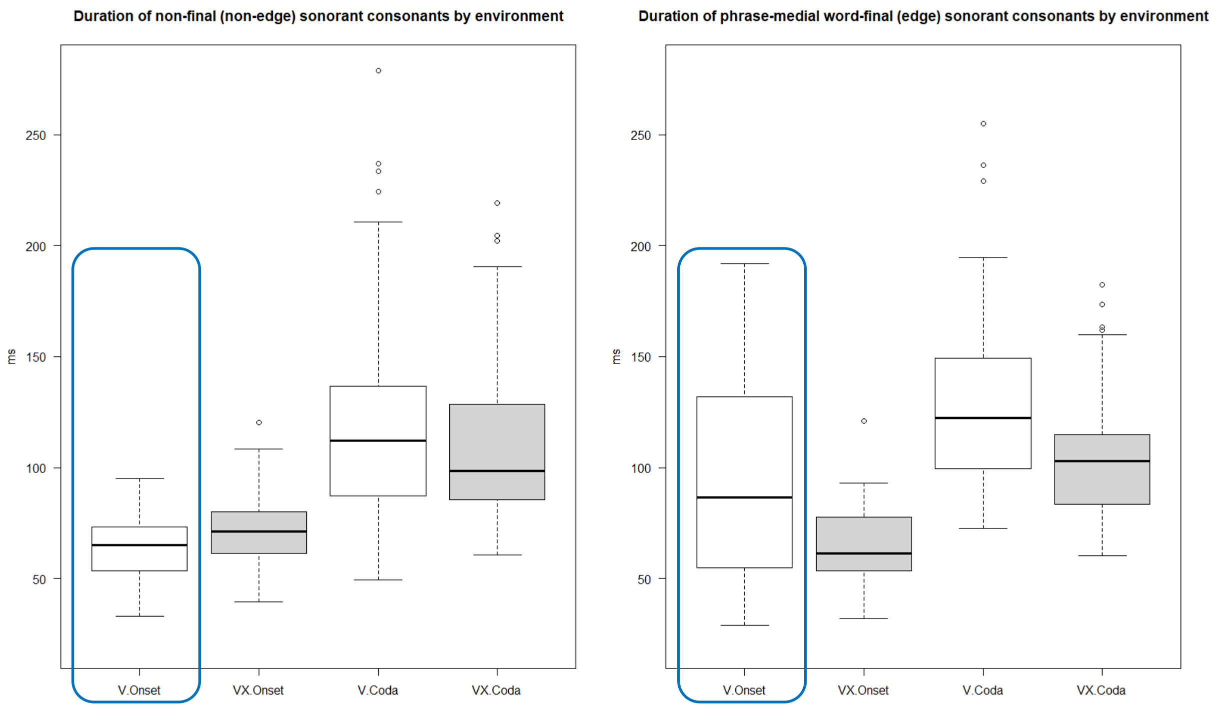


Fig. 51: Duration of non-final (non-edge) and word-final (edge) phrase-medial sonorant consonants according to preceding rhyme and syllable position

A comparison between the non-final and the final plots reveals a difference between word-internal onsets and onsets that result from resyllabification. It is highlighted in Fig. 51 above. This finding clearly runs counter to the assumption that onset sonorants pattern alike, regardless of their position within the word.

Table 41 below shows the mean duration of onset and coda sonorant consonants in the two contexts. As expected, coda sonorants are on average longer than their onset counterparts. This is particularly evident for the non-edge instances. Turning to the edge column, however, one subset of the onsets stands out. It is shaded below. With a mean of nearly 96 ms, these onset sonorants are unexpectedly long. Recall that ZG Onset Formation disregards word boundaries. The cells where the levels *edge* and *Onset* intersect contain instances where word-final consonants are syllabified in the onset of a following vowel-initial word. This observation raises the question of whether Onset Formation applies as straightforwardly as hitherto assumed.

		edge	non-edge	mean	example	
Onset	V	95.72	65.19	79.62	k͡xnɒl əmɒːl	rolə
	VX	64.13	72.63	68.81	mɒːl əmɒːl	foːlə
Coda	V	127.95	115.61	117.71	k͡xnɒl sofortː	fylʃ
	VX	105.20	108.88	107.31	mɒlː sofortː	hyːlʃ

Table 41: Mean duration (in ms) of coda and onset sonorant consonants by *word position*

Statistical analysis confirms this impression: *prec_rhyme* affects both onset and coda equally. The estimated fixed effects are given in (161), cf. App. 17.[263]

(161)	Onset	Coda
V	71	101
VX	56	79

For further analysis, the factor *word position* was included in the model. There was a 3-way interaction between *preceding rhyme, syllable position,* and *word position* $F(1, 178) = 8.557$, $p = .003891$), cf. App. 18. This made it necessary to split the data into two subsets: one containing the word-medial instances (non-edge) and one consisting of the data at word edge (edge).

For the non-edge sonorants, the statistical analysis revealed a main effect for the syllable position as well as an interaction between *syllable position* and *preceding rhyme.* The critical estimates are given in (162), cf. App. 19.

(162)	Onset	Coda
V	51	105
VX	59	94

263 This is of course an abbreviated form; details are provided in the Appendix I.

For the sonorants at the word edge, *syllable position* is a significant main effect. There is also a significant interaction between *syllable position* and *preceding rhyme* $F(1, 212) = 5.128$, $p = .02456$). As can be taken from the estimates in (163), coda and onset consonants are longer when preceded by a short vowel, however, and downright unexpectedly, the preceding rhyme has a greater effect on *onset* sonorants, cf. App. 20.

(163)	Onset	Coda
V	97	120
VX	64	102

The fact that onset sonorants preceded by a short vowel are considerably longer than when preceded by a long vowel is entirely unpredicted. The above analysis suggests that only a subset of the sonorants shows this behaviour. Word-medial data, on the other hand, pattern as expected. This, in turn, may indicate that the resyllabification does not proceed as assumed.

In order to account for these findings, the phrase-medial onset data were more closely inspected. The resyllabification data comprises two different syntactic contexts: Context A consists of imperative verbs followed by a schwa-initial adverb, (164)a). In context B, a predicative noun phrase is topicalised and followed by the vowel-initial copula, (b):

(164) a. /k͡xnɒl əmɒːl/ ‘bang once (imp.sg.)’ context A
b. /ən k͡xnɒl iʃ tɒs nøːt/ ‘a bang is this not’ context B

Fig. 52 illustrates that resyllabification occurs far more systematically in context A. As for context B, it is doubtful whether resyllabification applies at all. The boxplots show that the onsets in context B – marked below – are considerably longer than those in context A. In fact, if preceded by a short vowel, their duration resembles the duration of codas giving rise to the assumption that they are no onsets at all.

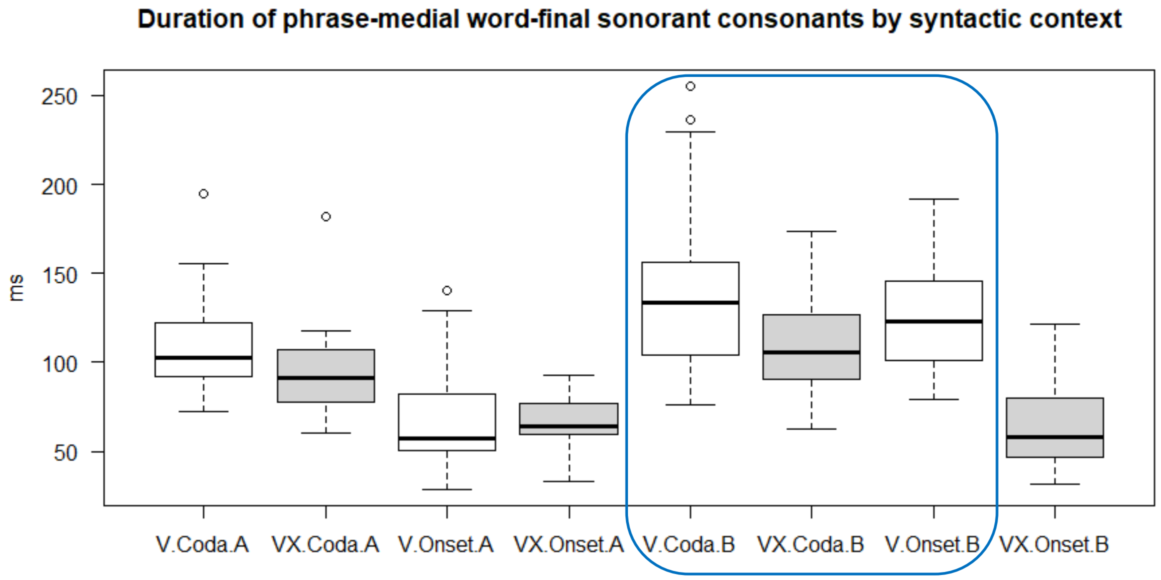


Fig. 52: Duration of phrase-medial word-final sonorant consonants according to syntactic context

If we assume that the long durations of the sonorants in context B indeed reflect the absence of resyllabification, let us discuss some possible explanations for this.

First, the failure of Onset Formation to apply across word boundaries could be accounted for as the result of a misleading experimental setting. The fact that the informants saw the target word prompted in isolation on the screen may have led them to articulate it with special care.[264] Additionally, the words are given in written form where it is often spelt with double consonants, e.g. *Knall* 'bang'. Since none of the speakers was linguistically trained, the visual impression of the word may have impacted the pronunciation.

However, the possible shortcomings of the experimental set-up cannot fully explain why resyllabification is absent only in context B, while present in context A. Another point of consideration involves the domain of Onset Formation. It might turn out that ZG Onset Formation is not as unbounded as previously thought, at least not as far as words ending in a sonorant are concerned. Future research is needed to determine the prosodic domains ZG refers to. The syntactic structure in context B was certainly very marked, which may have irritated some speakers. By aligning the syntactic boundary of the topicalised NP with a prosodic boundary, the speakers were able to further emphasise the markedness. As a result, resyllabification fails to apply in context B. By contrast, resyllabification occurs in context A where the sonorant in question is

264 Indeed, there are some indications which point in that direction, such as glottal stop insertion and the absence of linking elements (e.g. [ə ɒlpː] instead of regular [ən ɒlpː]). Furthermore, some speakers omitted assimilation.

not at the edge of a prosodic constituent that blocks Onset Formation, confirming that Onset Formation does apply across word boundaries.

A third line of reasoning concerns the morphology. Since sonorants are longer in coda position than in the onset, verbal forms are subject to paradigmatic alternation, e.g. [k͡xnɒ.lət] 'bang (1.pl.)' vs [k͡xnɒltː] 'bangs (3.sg)'. In the verbal paradigm, stem-final sonorants are either long or short, depending on their position within the syllable. This probably facilitates the extension of the pattern in context A. In nominal paradigms, on the other hand, we find virtually no paradigmatic alternation.[265] This probably makes resyllabification a less preferred option. Since there is considerable inter-subject variation, this may be a more recent and ongoing development. I leave it to further research.

After having established a subset where no Onset Formation occurs, the data were recoded. A total of 40 instances formerly considered onsets were relabelled as codas.

Table 42 provides an overview of the revised encodings in the data set. The shaded cells encompass instances of Winteler's Law.

			l	m	n	total
Onset			**47**	**56**	**48**	**151**
	V		**24**	**24**	**24**	**72**
		edge	8	8	8	24
		non-edge	16	16	16	48
	VX		**23**	**32**	**24**	**79**
		edge	8	8	8	24
		non-edge	15	24	16	55
Coda			**296**	**175**	**158**	**629**
	V		**249**	**96**	**96**	**441**
		edge	31	30	30	91
		non-edge	218	66	66	350
	VX		**47**	**79**	**62**	**188**
		edge	31	31	30	92
		non-edge	16	48	32	96
total			**343**	**231**	**206**	**780**

Table 42: Overview of the sonorant consonants in the data set (revised version)

[265] This is to do with the fact that only few of the monosyllabic nouns ending in a sonorant consonant have disyllabic forms in the nominal paradigm, cf. fn. 50.

An overall picture of onset and coda sonorants is given in Fig. 53. Compared to Fig. 51 above, the “quirky” onsets have vanished, and the boxplots now look very much in line with standard assumptions.

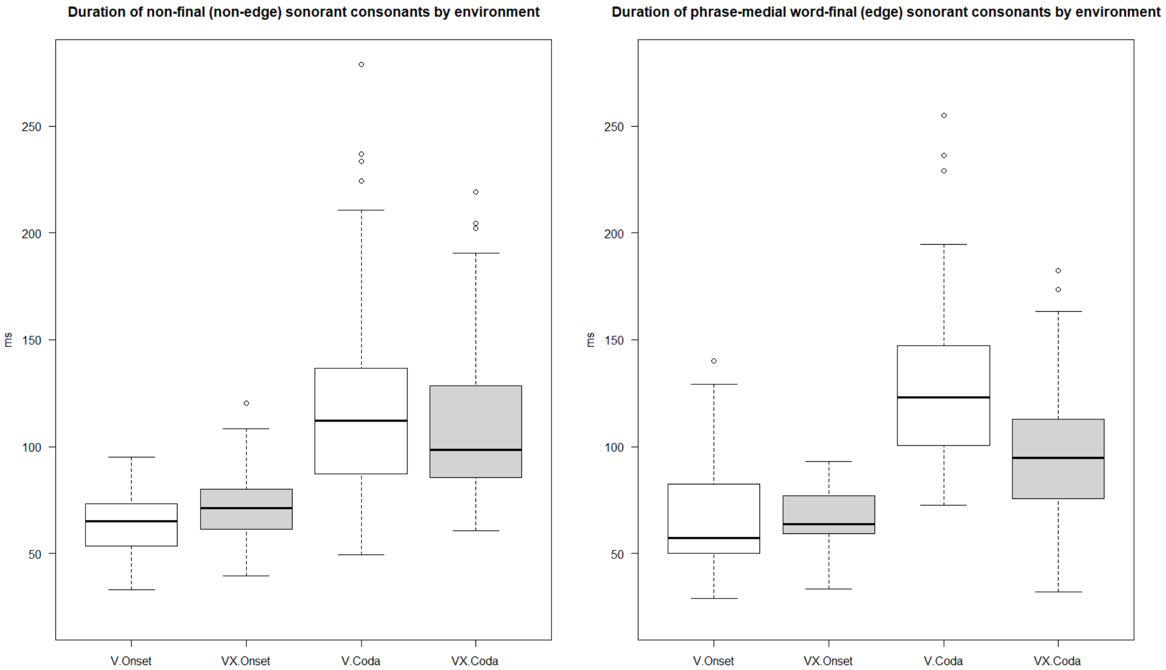


Fig. 53: Duration of non-final (non-edge) and word-final (edge) phrase-medial sonorant consonants according to preceding rhyme and syllable position (revised)

The average durations of onset and coda sonorants are given in Table 43. Coda consonants are nearly twice the duration of their onset counterparts. They are shorter when preceded by a long vowel or vowel-sonorant cluster, thus confirming Winteler’s initial impression.

		edge	non-edge	mean
Onset	V	70.04	65.19	66.81
	VX	65.17	72.63	70.37
Coda	V	127.99	115.61	118.16
	VX	95.55	108.88	102.36

Table 43: Mean duration (in ms) of coda and onset sonorant consonants by word position (revised)

The revised data were first analysed in terms of *preceding rhyme, syllable position,* and *word position.* There was a main effect for *preceding rhyme* and *syllable position,* as well as an interaction between these two factors (App. 21). *Word position* had no main effect and was not involved in significant interactions. It could, therefore, be removed from the model. The final analysis only evaluates the effects of *preceding rhyme* and *syllable position*. The estimates are shown in (165), cf. App. 22:

(165)	Onset	Coda
V	51	100
VX	53	84

There is a significant main effect for *syllable position.* Additionally, the interaction between *syllable position* and *preceding rhyme* ($F(1, 275) = 7.601$, $p = .006226$) is significant. This also holds true if we include category into the model (App. 23).

6.3.5. Summary Winteler's Law

The previous section investigated the empirical basis of Winteler's Law, which states that coda sonorants preceded by a short vowel are longer than elsewhere. This prediction could be partly confirmed. First, all sonorant consonants investigated showed the same behaviour. Although the duration of the lateral differs from that of the nasals, the category had no significant impact on the duration. Second, the measurements revealed that coda consonants are indeed significantly longer than onset consonants and they are longest when preceded by a short vowel. Insofar, the predictions made by Winteler are borne out. However, the difference between codas following a bipositional rhyme and codas preceded by a monopositional rhyme is quite small. After recoding the data, an interaction between the position within the syllable and the preceding environment could be determined. This can be viewed as indication that Winteler's Law has an empirical basis. Thirdly, the findings partly corroborate the assumption that ZG syllabification applies across word-boundaries.

A subset was identified where postlexical resyllabification failed to apply. It is unclear whether the absence of resyllabification in that particular environment is due to the experimental design or whether it depends on other factors. In particular, resyllabification may be restricted to certain prosodic categories (Nespor & Vogel 1982, 1986; Nespor 2007). Future research is necessary to determine which domains postlexical processes refer to.

The findings can be interpreted in terms of positional neutralisation: coda sonorants are longer than onset sonorants, precisely because of their position within the syllable.

The question of whether WbP only applies to sonorants when they follow a monopositional rhyme cannot be answered conclusively. Although the sonorants are slightly longer after the short vowel, the difference is rather small.

Let us finally compare the results to the heterosyllabic sonorants mentioned in 2.3.2.1. I identified two environments where the sonorants presumably have a geminate pronunciation. (166) repeats the six words which are in my corpus. Simplex words ending in *-ər* are given in (a). The examples in (b) are inflected adjectives.

(166)

	item	duration (in ms)
a.	xæl:ər 'cellar'	137.64
	t:un:ər 'thunder'	152.80
	t͡sim:ər 'room'	162.15
b.	ʃlim:ə 'bad'	113.14
	t:yn:i 'thin'	103.50
	fol:ə 'full'	89.34
	mean	127.22

Comparison with the durations of the coda consonants in Table 43 reveals that the sonorants in (166) are clearly longer than the onsets. They are also somewhat longer than sonorants that are restricted to the coda (i.e. are not realised heterosyllabically). This is particularly evident for the simplex words in (a). As regards to the adjectives, the variation between the speakers is considerable (cf. Fig. 6) and the average measured is likely to reflect the reality of the individual's category system only poorly.

The measurements hint at the existence of three different lengths: singletons, doubly linked heterosyllabic geminates, and singly linked moraic coda sonorants. In Moraic Theory, this is explained as follows: sonorants are non-moraic unless they are in the coda, where they get a structural mora via WbP. This seems to have been the system described by Weber (1948), cf. 2.3.2.1. In recent times, this system has changed in two ways. First, for adjectives, the stem-final sonorant retains its length even when it is not in the coda. Two explanations seem available: either, the sonorant is lexically long, that is, today's speakers have stored it as underlyingly moraic. ZG has thus introduced a lexical contrast that had not existed before. How exactly this restructuring of the phonological system took place needs further investigation. Another possibility is to explain the absence of resyllabification through the syllabification algorithm. Many languages refer to specific – including morphological and syntactic – domains for syllabification. An answer why it concerns only the adjectives in ZG is still pending. Second, sonorants are lengthened before *-ər*. A phonological explanation of why *-ər* triggers lengthening in ZG is unknown to me.[266] In particular, it is remarkable that the lengthening also occurs after long vowels. Kager & Zonneveld (1986) offer a possible solution, pointing to the exceptional behaviour of what they dub “schwallables” (i.e. syllables containing schwa). For Dutch, they propose an appendix for schwa syllables. Consequently, segments that immediately precede the schwallable are in the coda at some point of the derivation, which in our case could explain the lengthening.

However these changes came about, we have to assume two categories and three different phonetic lengths. Again, the aforementioned allophonic distribution comes into play: singletons have a “moraic allophone” when in coda position. Geminates are doubly linked due to Onset Maximization. Otherwise, they are singly associated with a mora. These assumptions make some implications. If there is alternation, as e.g. in the verb forms, the sonorant is underlyingly non-moraic. The preservation of length in intervocalic environments may indicate that the category is changing. The fact that resyllabification into the following onset sometimes failed to apply could also point in this direction.

266 Elvira Glaser (p.c.) pointed out to me that in accounts on Early Modern German consonant lengthening before *-ər* is viewed as an alternative to OSL in order to render a stressed syllable bimoraic (cf. Reichmann & Wegera 1993: 72; Paul 2007: 82). Such an explanation, however, is not possible for ZG, as ZG has no bimoraicity constraint on stressed syllables in disyllabic words.

7. Conclusion

The aim of this thesis was to determine the nature of the *fortis/lenis* distinction in ZG and neutralisation processes related to it. The most prominent finding to emerge from this study is that Heusler's Law is indeed a neutralisation that results in an intermediate value, as has been described by various scholars. Two adjacent obstruents are always neutralised. This is independent of whether the neutralised sounds are singletons ("lenes") or geminates ("fortes"). My investigation has also shown that neutralisation applies across word boundaries.

Another goal was to find out if Heusler's Law can be analysed as positional neutralisation. The prevailing opinion is that ZG obstruents are differentiated by the feature pair *fortis/lenis*. I have shown that this view is difficult to sustain, both phonetically and phonologically. Previous studies have shown that the phonetic correlate of the opposition is duration. Further phonetic correlates could not be conclusively determined. The measurements of the present work confirm the findings of these investigations. Phonologically, a length contrast is a suprasegmental contrast, that is, a singleton/geminate opposition. Various prosodic processes indicate the accuracy of an analysis as a singleton/geminate contrast. In particular, the requirement that ZG content words must have a minimum word size can be straightforwardly explained in Moraic Theory. Further phenomena such as stress assignment and compensatory lengthening provide additional evidence for an analysis which considers *fortes* as geminates and *lenes* as singletons.

In Chapter 2, I have laid out what has been recognised previously. ZG contrasts two rows for both the stops and the fricatives. The distinction involves neither voice nor aspiration and is independent of the quantity of the preceding vowel. Winteler attributed it to the force of articulation and coined the term pair *fortis/lenis.* It has since become firmly anchored in Swiss dialectology. Winteler also attributed a *fortis/lenis* contrast to the sonorants. This assumption was not adopted in later dialect descriptions. Instead, they state that sonorants differ in duration according to their position within the syllable. This difference, however, is not considered contrastive in ZG. However, although the distribution of long and short sonorants is mostly dependent on the quantity of the preceding vowel, I was able to identify two subsets where this no longer seems to apply: first, adjectives tend to retain their length throughout the paradigm, and second, lengthening occurs when the sonorant is followed by -*ər*.

The traditional term *fortis/lenis* encounters some difficulties in theoretical frameworks. The main problems were discussed in Chapter 3. They culminate in the observation that – contrary to the theoretical requirements at the time – no correlate has been found that describes *fortis/lenis* in a universal and unambiguous manner. The solution provided by Lisker & Abramson (1964) in terms of VOT is no viable option for ZG, since ZG stops have no distinctive laryngeal contrasts. On the other hand – as has been confirmed by empirical investigations including the present one – *fortes* are significantly longer than *lenes*. From a phonetic point of view, it therefore makes sense to describe *fortis/lenis* in terms of duration.

My brief review of the use of *fortis/lenis* – and subsequent tense/lax – has shown that a connection between *fortis/lenis* and duration has always been recognised. Phonologically, this raises the question of which of the two parameters is the primary one. In Chapter 4, I presented phonological reasons in favour of the latter, which add to the phonetic evidence. I have argued that *fortis/lenis* is more adequately analysed as a distinction between geminates and singletons. In Moraic Theory, the difference between singletons and geminates is represented by the absence or presence of a mora. Representing geminates as weight-bearing units makes strong predictions concerning quantity-based processes. It turned out that *fortis* and *lenis* consonants behave differently with regard to a variety of quantity-related phenomena. MSL in particular, but also observations on stress assignment support the argument that geminates *(fortes)* are moraic. X-Theory, which represents geminates as segments linked to two X-slots, cannot explain the relationship between geminates and quantity-sensitive processes in an equally straightforward way.

Crucially, Moraic Theory predicts that in certain positions non-moraic segments also receive a mora: coda consonants are assigned a structural mora by WbP. The validity of WbP in ZG can be shown in various weight-related processes. In monosyllabic words ending in a consonant cluster, the vowel is not lengthened, because the non-final consonant is assigned a mora. Additional evidence comes from stress placement where coda consonants contribute to syllable weight.

Winteler's Law refers to the coda position. Since moraic elements not only contribute to syllable weight, but are also phonetically longer, Moraic Theory predicts that sonorants in coda position are longer than in the onset. The phonetic measurements confirm this claim: coda sonorants are evidently longer than their onset counterparts.

A principal question of the present thesis is whether Heusler's Law can also be explained as positional neutralisation. In Chapter 5, I laid out that Heusler's Law is theoretically difficult to grasp, as the neutralised sound is somewhere "in between". With reference to the typology of Trubetzkoy, I have suggested that this intermediate value is due to positional conditions: the neutralised obstruent is associated with a mora, which is responsible for longer duration. Singleton consonants placed in the coda are longer than onset consonants, because the former are positionally moraic. On the other hand, geminates can also occur as singly linked if sonority restrictions prevent them from spreading to the onset of the next syllable. Under these circumstances singletons and geminates have the same structure. Therefore, they are indistinguishable, that is, they are neutralised.

Since the study was limited to labial obstruents, it is of course not possible to determine whether the results also apply to other places of articulation. In addition, my investigation with 8 informants was relatively small. Since all speakers were already aged over 40 at the time of the survey, they may represent a more conservative ZG. The described deviations from Weber's *Zürichdeutschen Grammatik* may illustrate how quickly the language can change within a few generations. The fact that Swiss dialects are not codified might increase that speed. Some may regret that. For linguists, it is the perfect language laboratory.

One source of weakness in this study, which could have affected the measurements, was that the data were not normalised. In the analysis, I tried to mitigate the impact of inter-subject variation by including the speaker as a random effect. When looking at the individual speakers, however, all show a similar pattern.

The study contributes to our understanding of neutralisation phenomena. It will be of interest to phoneticians and phonologists alike that work in these fields.

Several questions still remain unanswered. In particular, it is yet unclear why initial obstruents are subject to neutralisation. One possible solution is expressed in the cue-based approach (Steriade 1999; cf. 5.1.2): in C_1C_2 clusters, the second element is more prominent than the first. Jun (2011: 1106) mentions “post-obstruent tensing” in Korean as an example where the second member of an obstruent cluster gains additional prominence. However, the causes of neutralisation are very different depending on the obstruent’s position in the syllable. A unified explanation is, therefore, still pending.

I have not addressed the fact that neutralised geminates are systematically marginally longer than the singletons. Like any phonological theory, Moraic Theory is interested in contrasts. It does not offer an explanation. Nevertheless, the findings seem to point in a similar direction as the results by Braver & Kawahara (2014) on incomplete neutralisation of long vowels in Japanese. The neutralisation in ZG is, so to say, also “incomplete”, and the lexical contrast still shows through.

Further investigations should examine the historical dimension more closely. Since the ZG obstruent system evolved from a system that had a segmental contrast, it is conceivable that this origin still influences the phonology of ZG. Investigating systems that shift – or have shifted – from a segmental to a suprasegmental contrast seems to be a worthwhile task that ultimately contributes to a better understanding of ZG.

Another exciting area of research concerns the development of the sonorants. In this thesis, it could only be addressed briefly. It seems to me that the sonorant system has changed fundamentally, and it is likely that the development is still ongoing. This is a unique opportunity to investigate linguistic change while it is happening.

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Appendix

I. Estimates

i. Stops

App. 1: *Fixed effect coefficient estimates,*
VOT ~ condition

	Estimate	SE	df	t value	Pr(>|t|)
(Intercept)	25.81	2.10	39	12.27	7.11e-15 ***
Conditionneutrs	-1.06	1.67	676	-0.64	0.5242
Conditionneutrg	-2.41	2.83	47	-0.85	0.4002
Conditiongeminate	-6.80	2.81	45	-2.42	0.0195 *

App. 2: *Fixed effect coefficient estimates,*
VOT (revised) ~ condition

	Estimate	SE	df	t value	Pr(>|t|)
(Intercept)	23.69	1.55	30	15.29	8.88e-16 ***
Conditionneutrs	1.37	1.09	648	1.25	0.211
Conditionneutrg	0.72	1.91	46	0.38	0.707
Conditiongeminate	0.17	1.92	47	0.09	0.929

App. 3: *Fixed effect coefficient estimates,*
*closure duration ~ condition*preceding rhyme* position*

	Estimate	SE	df	t value	Pr(>|t|)
(Intercept)	69.78	9.52	44	7.33	3.90e-09 ***
Conditionneutrs	36.52	11.74	43	3.11	0.003322 **
Conditionneutrg	46.23	12.30	47	3.76	0.000472 ***
Conditiongeminate	131.26	12.30	47	10.67	3.71e-14 ***
Positionbetween	0.80	9.71	42	0.08	0.934341
prec_rhymeVX	-2.60	10.17	43	-0.26	0.799597
conditionneutrs:positionbetween	-5.57	12.63	56	-0.44	0.661049
conditionneutrg:positionbetween	9.83	14.60	46	0.67	0.503972
conditiongeminate:positionbetween	-61.70	14.07	43	-4.39	7.28e-05 ***
conditionneutrs:prec_rhymeVX	-19.54	14.38	43	-1.36	0.181226
conditionneutrg:prec_rhymeVX	-28.75	14.38	43	-2.00	0.051923 .
conditiongeminate:prec_rhymeVX	-51.13	14.39	43	-3.55	0.000947 ***
positionbetween:prec_rhymeVX	-11.85	11.72	49	-1.01	0.316853
conditionneutrs:positionbetween:prec_rhymeVX	16.95	15.67	59	1.08	0.283572
conditionneutrg:positionbetween:prec_rhymeVX	12.80	17.60	53	0.73	0.470213
conditiongeminate:positionbetween:prec_rhymeVX	32.72	16.80	51	1.95	0.057056 .

App. 4: *Fixed effect coefficient estimates,*
closure duration ~ condition position*

	Estimate	SE	df	t value	Pr(>|t|)
(Intercept)	68.04	8.44	38	8.06	9.06e-10 ***
Conditionneutrs	23.49	10.29	36	2.28	0.02845 *
Conditionneutrg	27.06	10.82	40	2.50	0.01651 *
Conditiongeminate	97.15	10.83	41	8.97	3.49e-11 ***
Positionbetween	-7.18	9.38	33	-0.77	0.44968
conditionneutrs:positionbetween	11.12	10.67	42	1.04	0.30318
conditionneutrg:positionbetween	16.68	13.49	33	1.24	0.22513
conditiongeminate:positionbetween	-40.56	13.46	33	-3.01	0.00498 **

App. 5: *Fixed effect coefficient estimates, closure duration ~ condition* preceding rhyme*

	Estimate	SE	df	t value	Pr(>|t|)
(Intercept)	72.84	7.71	36	9.44	3.17e-11 ***
Conditionneutrs	31.00	4.58	612	6.78	2.92e-11 ***
Conditionneutrg	65.60	10.42	71	6.30	2.25e-08 ***
Conditiongeminate	83.06	9.78	65	8.50	4.07e-12 ***
prec_rhymeVX	-13.75	6.51	163	-2.11	0.0362 *
conditionneutrs:prec_rhymeVX	-3.64	6.05	600	-0.60	0.5479
conditionneutrg:prec_rhymeVX	-21.12	10.81	151	-1.95	0.0525 .
conditiongeminate:prec_rhymeVX	-24.34	9.49	169	-2.57	0.0112 *

App. 6: *Fixed effect coefficient estimates, closure duration ~ condition (non-neutralised)* position*

	Estimate	SE	df	t value	Pr(>|t|)
(Intercept)	68.04	8.34	30	8.16	4.69e-09 ***
Conditiongeminate	97.19	12.33	30	7.88	9.30e-09 ***
Positionbetween	-6.05	9.90	23	-0.61	0.54705
conditiongeminate:positionbetween	-42.26	14.22	23	-2.97	0.00683 **

App. 7: *Fixed effect coefficient estimates, closure duration ~ condition (non-neutralised)* phrasal position*

	Estimate	SE	df	t value	Pr(>|t|)
(Intercept)	63.39	5.79	13	10.95	4.96e-08 ***
Conditiongeminate	49.90	9.12	15	5.47	7.19e-05 ***
PhrasalPositionwordinitial	-10.23	13.93	9	-0.73	0.482
conditiongeminate:PhrasalPositionwordinitial	35.20	19.83	9	1.78	0.111

App. 8: *Fixed effect coefficient estimates, closure duration ~ condition (non-neutralised)* preceding rhyme*

	Estimate	SE	df	t value	Pr(>|t|)
(Intercept)	72.58	7.92	43	9.17	1.12e-11 ***
conditiongeminate	91.68	12.19	41	7.52	2.90e-09 ***
prec_rhymeVX	-12.94	7.39	131	-1.75	0.0822 .
conditiongeminate:prec_rhymeVX	-25.66	10.79	135	-2.38	0.0188 *

App. 9: *Fixed effect coefficient estimates, closure duration ~ condition (neutralised)* position*

	Estimate	SE	df	t value	Pr(>|t|)
(Intercept)	91.54	8.41	22	10.89	2.27e-10 ***
Conditionneutrg	3.57	8.87	25	0.40	0.691
Positionbetween	2.64	8.14	23	0.33	0.748
conditionneutrg:positionbetween	7.79	11.68	23	0.67	0.512

App. 10: *Fixed effect coefficient estimates, closure duration ~ condition (neutralised)* phrasal position*

	Estimate	SE	df	t value	Pr(>|t|)
(Intercept)	93.22	7.38	14	12.64	4.22e-09 ***
Conditionneutrg	9.35	7.63	10	1.23	0.248
PhrasalPositionwordinitial	6.85	13.52	7	0.51	0.627
conditionneutrg:PhrasalPositionwordinitial	11.17	19.24	7	0.58	0.579

App. 11: *Fixed effect coefficient estimates, closure duration ~ condition (neutralised)* preceding rhyme*

	Estimate	SE	df	t value	Pr(>|t|)
(Intercept)	103.80	7.69	10	13.50	1.53e-07 ***
Conditionneutrg	15.74	5.12	17	3.08	0.007020 **
prec_rhymeVX	-18.77	4.33	16	-4.34	0.000496 ***
conditionneutrg:prec_rhymeVX	-12.00	6.41	17	-1.87	0.078504 .

App. 12: *Fixed effect coefficient estimates, closure duration ~ condition (neutralised)* adjacent consonant*

	Estimate	SE	df	t value	Pr(>|t|)
(Intercept)	96.28	7.63	19	12.62	1.46e-10 ***
Conditionneutrg	3.73	7.61	36	0.49	0.627
adjacent.C_Singleton	-6.21	4.65	279	-1.34	0.183
adjacent.CGeminate_	-0.02	15.67	17	0.00	0.999
adjacent.CSingleton_	7.00	15.62	17	0.45	0.660
conditionneutrg:adjacent.C_Singleton	4.55	6.99	257	0.65	0.516
conditionneutrg:adjacent.CGeminate_	15.42	22.23	17	0.69	0.497
conditionneutrg:adjacent.CSingleton_	18.77	22.20	17	0.85	0.409

ii. Fricatives

App. 13: *Fixed effect coefficient estimates,*
duration ~ condition (non-neutralised) position*

	Estimate	SE	df	t value	SEPr(>|t|)
(Intercept)	108.88	8.69	23	12.53	1.01e-11 ***
categoryf:	83.38	10.91	22	7.64	1.23e-07 ***
positionbetween	-14.33	10.64	16	-1.35	0.1970
categoryf::positionbetween	-24.27	13.78	16	-1.76	0.0971 .

App. 14: *Fixed effect coefficient estimates,*
duration ~ condition (non-neutralised) preceding rhyme*

	Estimate	SE	df	t value	Pr(>|t|)
(Intercept)	112.25	10.06	52	11.16	2.22e-15 ***
Conditiongeminate	79.47	13.88	31	5.73	2.82e-06 ***
prec_rhymeVX	-12.65	7.60	229	-1.66	0.0974 .
conditiongeminate:prec_rhymeVX	-16.70	13.82	31	-1.21	0.2362

App. 15: *Fixed effect coefficient estimates,*
*duration ~ condition (neutralised) * position*

	Estimate	SE	df	t value	Pr(>|t|)
(Intercept)	100.50	14.68	19	6.84	1.77e-06 ***
Conditionneutrg	9.02	16.05	16	0.56	0.582
Positionbetween	11.57	16.49	14	0.70	0.494
conditionneutrg:positionbetween	7.91	19.80	14	0.40	0.695

iii. Sonorants

App. 16: *Fixed effect coefficient estimates, segment duration sonorants ~ category*preceding rhyme*syllable position*

	Estimate	SE	df	t value	Pr(>|t|)
(Intercept)	73.41	8.41	44	8.73	3.53e-11 ***
categorym	21.47	10.09	189	2.13	0.0346 *
categoryn	21.50	10.01	199	2.15	0.0330 *
prec_rhymeVX	-10.79	10.39	145	-1.04	0.3009
syll_positionCoda	28.10	6.58	477	4.27	2.36e-05 ***
categorym:prec_rhymeVX	-5.18	14.23	149	-0.36	0.7163
categoryn:prec_rhymeVX	-17.55	14.77	140	-1.19	0.2368
categorym:syll_positionCoda	5.77	9.59	512	0.60	0.5477
categoryn:syll_positionCoda	6.08	9.59	512	0.63	0.5265
prec_rhymeVX:syll_positionCoda	5.70	9.74	601	0.59	0.5585
categorym:prec_rhymeVX:syll_positionCoda	-4.72	13.50	598	-0.35	0.7267
categoryn:prec_rhymeVX:syll_positionCoda	7.02	13.88	593	0.51	0.6134

App. 17: *Fixed effect coefficient estimates, segment duration sonorants ~ preceding rhyme*syllable position*

	Estimate	SE	df	t value	Pr(>|t|)
(Intercept)	71.72	6.82	14	10.51	6.40e-08 ***
prec_rhymeVX	-15.96	5.78	197	-2.76	0.00628 **
syll_positionCoda	30.51	3.95	535	7.73	5.35e-14 ***
prec_rhymeVX:syll_positionCoda	7.77	5.55	609	1.40	0.16219

App. 18: *Fixed effect coefficient estimates, segment duration sonorants ~ preceding rhyme*syllable position*word position*

	Estimate	SE	df	t value	Pr(>|t|)
(Intercept)	82.23	8.97	27	9.17	9.51e-10 ***
prec_rhymeVX	-34.16	9.67	76	-3.53	0.000705 ***
syll_positionCoda	23.45	4.62	700	5.07	5.08e-07 ***
wd_positionnon-edge	-33.58	9.63	74	-3.49	0.000821 ***
prec_rhymeVX:syll_positionCoda	15.98	6.48	699	2.47	0.013924 *
prec_rhymeVX:wd_positionnon-edge	42.71	13.15	81	3.25	0.001699 **
syll_positionCoda:wd_positionnon-edge	30.89	8.65	140	3.57	0.000486 ***
prec_rhymeVX:syll_positionCoda:wd_positionnon-edge	-35.61	12.17	178	-2.93	0.003891 **

App. 19: *Fixed effect coefficient estimates, segment duration sonorants ~ preceding rhyme*syllable position (subset sonorants non-edge)*

	Estimate	SE	df	t value	Pr(>|t|)
(Intercept)	51.56	8.93	26	5.77	4.24e-06 ***
prec_rhymeVX	8.40	8.54	70	0.98	0.3287
syll_positionCoda	54.53	7.02	59	7.76	1.33e-10 ***
prec_rhymeVX:syll_positionCoda	-19.97	9.88	78	-2.02	0.0467 *

App. 20: *Fixed effect coefficient estimates, segment duration sonorants ~ preceding rhyme*syllable position (subset sonorants edge)*

	Estimate	SE	df	t value	Pr(>|t|)
(Intercept)	97.63	10.14	16	9.63	3.59e-08 ***
prec_rhymeVX	-33.89	13.05	12	-2.60	0.0229 *
syll_positionCoda	23.70	5.03	212	4.72	4.37e-06 ***
prec_rhymeVX:syll_positionCoda	15.92	7.03	212	2.27	0.0246 *

App. 21: *Fixed effect coefficient estimates, segment duration sonorants ~ preceding rhyme*syllable position*word position (revised)*

	Estimate	SE	df	t value	Pr(>|t|)
(Intercept)	61.35	9.59	38	6.40	1.64e-07 ***
prec_rhymeVX	-12.75	10.85	135	-1.18	0.2421
syll_positionCoda	44.82	6.68	754	6.71	3.95e-11 ***
wd_positionnon-edge	-14.13	9.96	102	-1.42	0.1589
prec_rhymeVX:syll_positionCoda	-16.19	9.45	754	-1.71	0.0872 .
prec_rhymeVX:wd_positionnon-edge	20.92	13.75	112	1.52	0.1309
syll_positionCoda:wd_positionnon-edge	9.97	9.58	213	1.04	0.2996
prec_rhymeVX:syll_positionCoda:wd_positionnon-edge	-4.02	13.61	251	-0.30	0.7683

App. 22: *Fixed effect coefficient estimates, segment duration sonorants ~ preceding rhyme*syllable position (revised)*

	Estimate	SE	df	t value	Pr(>|t|)
(Intercept)	51.97	7.19	17	7.23	1.63e-06 ***
prec_rhymeVX	2.06	6.29	168	0.33	0.74418
syll_positionCoda	49.44	4.77	232	10.38	< 2e-16 ***
prec_rhymeVX:syll_positionCoda	-18.65	6.77	275	-2.76	0.00623 **

App. 23: *Fixed effect coefficient estimates, segment duration sonorants ~ category*preceding rhyme*syllable position (revised)*

	Estimate	SE	df	t value	Pr(>|t|)
(Intercept)	57.89	9.28	58	6.24	5.63e-08 ***
categorym	23.82	11.22	149	2.12	0.0354 *
categoryn	16.93	11.18	151	1.52	0.1318
prec_rhymeVX	11.09	11.25	138	0.99	0.3263
syll_positionCoda	44.74	7.94	197	5.63	6.07e-08 ***
categorym:prec_rhymeVX	-11.31	15.24	144	-0.74	0.4593
categoryn:prec_rhymeVX	-19.81	15.89	136	-1.25	0.2147
categorym:syll_positionCoda	5.05	11.54	211	0.44	0.6623
categoryn:syll_positionCoda	14.38	11.54	211	1.25	0.2143
prec_rhymeVX:syll_positionCoda	-25.11	12.06	246	-2.08	0.0383 *
categorym:prec_rhymeVX:syll_positionCoda	4.37	16.40	256	0.27	0.7900
categoryn:prec_rhymeVX:syll_positionCoda	10.32	17.05	242	0.61	0.5456

II. Word list

Target Word (ZG)			Carrier Phrase (StG)		Cons.
ahnsch	ɒːnʃ	suspect (2.sg.)	Du ___ und ___ .	You ___ and ___ .	n
ahnt	ɒːntː	suspect (3.sg.)	Er ___ und ___.	He ___ and ____.	n
Alp	ɒlpː	alp	Ein(e) ___ ist das nicht.	A ___ is this not.	pː
Alp		alp	Es hat ___ gegeben.	There was a ___.	pː
Alp		alp	Ich habe den ___ nicht erwartet.	I did not expect the ___.	pː
Alp		alp	weil es ein(e) ___ gibt	because there was a ___	pː
Alp		alp	Ein(e) ___ ist das nicht.	A ___ is this not.	pː
Alp		alp	Es hat ___ gegeben.	There was a ___.	pː
Alp		alp	Ich habe den ___ nicht erwartet.	I did not expect the ___.	pː
Alp		alp	weil es ___ gibt	because there was a ___	pː
am Zwölfi	t͡sʊølfi	at twelve o'clock	Ich sage ___.	I say ___.	l
Amt	ɒmtː	office	Ich sage ___ und nochmals ___.	I say ___ and again ___.	m
Bass	bɒsː	bass	Ich sage der arme___.	I say the poor ___ .	p
Bass		bass	Ich sage der brave____.	I say the good ___ .	p
Bass		bass	Ich sage der grosse____.	I say the big ___ .	p
Bass		bass	Ich sage der karge___.	I say the barren ___ .	p
Bass		bass	Ich sage der kleine___.	I say the little ___ .	p
Bass		bass	Ich sage der scharfe___.	I say the hot ___ .	p
Bass		bass	Ich sage der schlimme____.	I say the terrible ___ .	p
Bass		bass	Ich sage der straffe____.	I say the firm ___ .	p
Bass		bass	Ich sage der zahme___.	I say the tame ___ .	p
Bass		bass	Ich sage der__.	I say the ___ .	p
Bass		bass	Sag ___!	Say ___!	p
Bass		bass	Ich sage der arme___.	I say the poor	p
Bass		bass	Ich sage der brave____.	I say the good	p
Bass		bass	Ich sage der grosse____.	I say the big	p
Bass		bass	Ich sage der karge___.	I say the barren	p
Bass		bass	Ich sage der kleine___.	I say the little	p
Bass		bass	Ich sage der scharfe___.	I say the hot	p
Bass		bass	Ich sage der schlimme____.	I say the terrible	p
Bass		bass	Ich sage der straffe____.	I say the firm	p
Bass		bass	Ich sage der zahme___.	I say the tame	p
Bass		bass	Ich sage der__.	I say the	p
Bass		bass	Sag ___!	Say ___!	p
Bohne	poːnə	bean	Ich sage ___.	I say ___.	n
Brääme	prɛːmə	horsefly	Ich sage ___.	I say ___.	m
brämse	præmsə	brake	Ich sage ___.	I say ___.	m
Chalb	xɒlp	calf	Es hat ein(e) gegeben.	There was a ___.	p
Chalb		calf	Ich habe den ___ nicht erwartet.	I did not expect the ___.	p
Chalb		calf	weil es ___ gibt.	because there was a ___	p
Chalb		calf	Es hat ___ gegeben.	There was a ___.	p
Chalb		calf	Ich habe den ___ nicht erwartet.	I did not expect the ___.	p
Chalb		calf	weil es ___ gibt	because there was a ___	p
Coop	kːoːpː	Coop	Ein(e) ___ ist das nicht.	A ___ is this not.	pː
Coop		Coop	Es hat ___ gegeben.	There was a ___.	pː
Coop		Coop	Ich habe den ___ nicht erwartet.	I did not expect the ___.	pː
Coop		Coop	weil es ___ gibt	because there was a ___	pː
Coop		Coop	Ein(e) ___ ist das nicht.	A ___ is this not.	pː
Coop		Coop	Es hat ___ gegeben.	There was a ___.	pː
Coop		Coop	Ich habe den ___ nicht erwartet.	I did not expect the ___.	pː

Target Word (ZG)			Carrier Phrase (StG)		Cons.
Coop		Coop	weil es ___ gibt	because there was a ___	pː
en braave Hund	prɒːfə	a good dog	Ich sage ___.	I say ___.	f
Fisch	fiʃ	fish	Ich sage der ___.	I say the ___ .	f
Fisch		fish	Ich sage der arme ___.	I say the poor ___ .	f
Fisch		fish	Ich sage der grosse ___.	I say the big ___ .	f
Fisch		fish	Ich sage der karge ___.	I say the barren ___ .	f
Fisch		fish	Ich sage der kleine ___.	I say the little ___ .	f
Fisch		fish	Ich sage der schlimme ___.	I say the terrible ___ .	f
Fisch		fish	Ich sage der zahme ___.	I say the tame ___ .	f
Fisch		fish	Sag ___!	Say ___!	f
Fisch		fish	Ich sage der ___.	I say the	f
Fisch		fish	Ich sage der arme ___.	I say the poor .	f
Fisch		fish	Ich sage der grosse ___.	I say the big	f
Fisch		fish	Ich sage der karge ___.	I say the barren	f
Fisch		fish	Ich sage der kleine ___.	I say the little	f
Fisch		fish	Ich sage der schlimme ___.	I say the terrible	f
Fisch		fish	Ich sage der zahme ___.	I say the tame	f
Fisch		fish	Sag ___!	Say ___!	f
Fohle	foːlə	foal	Ich sage ___.	I say ___.	l
fremd	fremt	foreign	Ich sage ___ und nochmals ___.	I say ___ and again ___.	m
Front	frontː	front	Ich sage ___ und nochmals ___.	I say ___ and again ___.	n
füllsch	fylʃ	fill (2.sg.)	Du ___ und ___.	You ___ and ___.	l
füllt	fyltː	fill (3.sg.)	Er ___ und ___.	He ___ and ____.	l
Gans	kɒns	goose	Ich sage ___ und nochmals ___.	I say ___ and again ___.	n
grob	krop	coarse	Es hat ___ gegeben.	He was	p
grob		coarse	Ich habe den ___ nicht erwartet.	I did not expect it ___.	p
grob		coarse	___ ist das nicht	A ___ is this not.	p
grob		coarse	weil es (ihn) ___ gibt	because it was ___	p
grob		coarse	Es hat ___ gegeben.	He was	p
grob		coarse	Ich habe den ___ nicht erwartet.	I did not expect it ___.	p
grob		coarse	___ ist das nicht.	A ___ is this not.	p
grob		coarse	weil es (ihn)_ gibt	because it was ___	p
Hafe	hɒfə	harbour	Ich sage ___.	I say ___.	f
hälffed	hælfːət	help (1.pl.)	Wir ___.	We ___.	l
Hamster	hɒmʃtər	hamster	Ich sage ___.	I say ___.	m
Hand	hɒnt	hand	Ich sage ___ und nochmals ___.	I say ___ and again ___.	n
hilffsch	hilfːʃ	help (2.sg.)	Du ___ und ___.	You ___ and ___.	fː
hilffsch		help (2.sg.)	Du ___ und ___.	You ___ and ___.	l
hilfft	hilfːtː	help (3.sg.)	Er ___ und ___.	He ___ and ____.	l
huped	huːpːət	honk (1.pl.)	Wir ___.	We ___.	pː
Huube	huːpə	hood	Ich sage ___.	I say ___.	p
hüülsch	hyːlʃ	cry (2.sg.)	Du ___ und ___.	You ___ and ___.	l
hüült	hyːltː	cry (3.sg.)	Er ___ und ___.	He ___ and ____.	l
huup	huːpː	honk	___ emaal!	___ once! (imp.sg)	pː
huup		honk	___ nomaal!	___ again! (imp.sg.)	pː
huup		honk	___ sofort!	___ at once! (imp.sg.)	pː
huup		honk	___ emaal!	___ once! (imp.sg)	pː
huup		honk	___ nomaal!	___ again! (imp.sg.)	pː
huup		honk	___ sofort!	___ at once! (imp.sg.)	pː
Huupi	huːpːi	hooter	Ich sage ___.	I say ___.	pː
huupsch	huːpːʃ	honk (2.sg.)	Du ___ und ___.	You ___ and ___.	pː
huupt	huːpːtː	honk (3.sg.)	Er ___ und ___.	He ___ and ____.	pː
kännsch	k͡xænʃ	know (2.sg.)	Du ___ und ___.	You ___ and ___.	n

Target Word (ZG)			Carrier Phrase (StG)		Cons.
kännt	k͡xænt	know (3.sg.)	Er ___ und ___.	He ___ and ____.	n
klöned	xløːnət	moan	Wir ___.	We ___.	n
knalled	k͡xnɒlət	bang (1.pl.)	Wir ___.	We ___.	l
loob	loːp	praise	___ emaal!	___ once! (imp.sg)	p
loob		praise	___ nomaal!	___ again! (imp.sg.)	p
loob		praise	___ sofort!	___ at once! (imp.sg.)	p
Loob		praise	Ein(e) ___ ist das nicht.	A ___ is this not.	p
Loob		praise	Es hat ___ gegeben.	There was a ___.	p
Loob		praise	Ich habe den ___ nicht erwartet.	I did not expect the ___.	p
Loob		praise	weil es ___ gibt	because there was a ___	p
loob		praise	___ emaal!	___ once! (imp.sg)	p
loob		praise	___ nomaal!	___ again! (imp.sg.)	p
loob		praise	___ sofort!	___ at once! (imp.sg.)	p
Loob		praise	Ein(e) ___ ist das nicht.	A ___ is this not.	p
Loob		praise	Es hat ___ gegeben.	There was a ___.	p
Loob		praise	Ich habe den ___ nicht erwartet.	I did not expect the ___.	p
Loob		praise	weil es ___ gibt	because there was a ___	p
loobed	loːpət	praise (1.pl.)	Wir ___.	We ___.	p
loobsch	loːpʃ	praise (2.sg.)	Du ___ und ___.	You ___ and ___.	p
loobt	loːptː	praise (3.sg.)	Er ___ und ___.	He ___ and ____.	p
mälche	mælxə	milk	Ich sage ___.	I say ___.	l
Monster	monʃtər	monster	Ich sage ___.	I say ___.	n
Name	nɒmə	name	Ich sage ___.	I say ___.	m
Pass	pːɒsː	passport	Ich sage der arme___.	I say the poor ___ .	pː
Pass		passport	Ich sage der brave____.	I say the good ___ .	pː
Pass		passport	Ich sage der grosse____.	I say the big ___ .	pː
Pass		passport	Ich sage der karge____.	I say the barren ___ .	pː
Pass		passport	Ich sage der kleine____.	I say the little ___ .	pː
Pass		passport	Ich sage der scharfe__.	I say the hot ___ .	pː
Pass		passport	Ich sage der schlimme__.	I say the terrible ___ .	pː
Pass		passport	Ich sage der straffe__.	I say the firm ___ .	pː
Pass		passport	Ich sage der zahme____.	I say the tame ___ .	pː
Pass		passport	Ich sage der____.	I say the ___ .	pː
Pass		passport	Sag ___!	Say ___!	pː
Pass		passport	Ich sage der arme___.	I say the poor	pː
Pass		passport	Ich sage der brave____.	I say the good	pː
Pass		passport	Ich sage der grosse____.	I say the big	pː
pfiiffe	p͡fiːfːə	whistle	Ich sage ___.	I say ___.	fː
Polster	pːolʃtər	cushion	Ich sage ___.	I say ___.	l
Qualm	k͡xʊɒlm	smoulder	Ich sage ___ und nochmals ___.	I say ___ and again ___.	l
qualme	k͡xʊɒlmə	smoulder (inf.)	Ich sage ___.	I say ___.	l
qualmsch	k͡xʊɒlmʃ	smoulder (2.sg.)	Du ___ und ___.	You ___ and ___.	l
qualmsch		smoulder (2.sg.)	Du ___ und ___.	You ___ and ___.	m
qualmt	k͡xʊɒlmtː	smoulder (3.sg.)	Er ___ und ___.	He ___ and ____.	l
Ramsch	rɒmʃ	junk	Ich sage ___ und nochmals ___.	I say ___ and again ___.	m
räned	rænət	run (1.pl.)	Wir ___.	We ___.	n
Rappe	rɒpːə	cent	Ich sage ___.	I say ___.	pː
Role	rolə	role	Ich sage ___.	I say ___.	l
schab	ʃɒp	scratch	___ emaal!	___ once! (imp.sg)	p
schab		scratch	___ nomaal!	___ again! (imp.sg.)	p
schab		scratch	___ sofort!	___ at once! (imp.sg.)	p
schab		scratch	___ emaal!	___ once! (imp.sg)	p
schab		scratch	___ nomaal!	___ again! (imp.sg.)	p

Target Word (ZG)			Carrier Phrase (StG)		Cons.
schab		scratch	___ sofort!	___ at once! (imp.sg.)	p
Schabe	ʃɒpə	cockroach	Ich sage ___.	I say ___.	p
schabed	ʃɒpət	scratch (1.pl.)	Wir ___.	We ___.	p
schabsch	ʃɒpʃ	scratch (2.sg.)	Du ___ und ___.	You ___ and ___.	p
schabt	ʃɒptː	scratch (3.sg.)	Er ___ und ___.	He ___ and ____.	p
schämed eus	ʃæmət	be ashamed (1.pl.)	Wir ___.	We ___.	m
Schärffi	ʃɛːrfːi	sharpness	Ich sage ___.	I say ___.	fː
schnapp	ʃnɒpː	catch	___ emaal!	___ once! (imp.sg)	pː
schnapp		catch	___ nomaal!	___ again! (imp.sg.)	pː
schnapp		catch	___ sofort!	___ at once! (imp.sg.)	pː
schnapp		catch	___ emaal!	___ once! (imp.sg)	pː
schnapp		catch	___ nomaal!	___ again! (imp.sg.)	pː
schnapp		catch	___ sofort!	___ at once! (imp.sg.)	pː
schnapped	ʃnɒpːet	catch (1.pl.)	Wir ___.	We ___.	pː
schnappsch	ʃnɒpːʃ	catch (2.sg.)	Du ___ und ___.	You ___ and ___.	pː
schnappt	ʃnɒpːtː	catch (3.pl.)	Er ___ und ___.	He ___ and ____.	pː
schnuufed	ʃnuːfət	breathe (1.pl.)	Wir ___.	We ___.	f
schnuufsch	ʃnuːfʃ	breathe (2.sg.)	Du ___ und ___.	You ___ and ___.	f
schnuuft	ʃnuːftː	breathe (3.sg.)	Er ___ und ___.	He ___ and ____.	f
schuumt	ʃuːmtː	foam (3.sg.)	Er ___ und ___.	He ___ and ____.	m
Schwalbe	ʃʊɒlpə	swallow	Ich sage ___.	I say ___.	l
schwümmt	ʃʊymtː	swim (3.sg.)	Er ___ und ___.	He ___ and ____.	m
Snob	snop	snob	Ein(e) ___ ist das nicht.	A ___ is this not.	p
Snob		snob	Es hat ___ gegeben.	There was a ___.	p
Snob		snob	Ich habe den ___ nicht erwartet.	I did not expect the ___.	p
Snob		snob	weil es ___ gibt	because there was a ___	p
Snob		snob	Ein(e) ___ ist das nicht.	A ___ is this not.	p
Snob		snob	Es hat ___ gegeben.	There was a ___.	p
Snob		snob	Ich habe den ___ nicht erwartet.	I did not expect the ___.	p
Snob		snob	weil es ___ gibt	because there was a ___	p
Stopp	ʃtopː	stop	Ein(e) ___ ist das nicht.	A ___ is this not.	pː
Stopp		stop	Es hat ___ gegeben.	There was a ___.	pː
Stopp		stop	Ich habe den ___ nicht erwartet.	I did not expect the ___.	pː
Stopp		stop	weil es ein(en) ___ gibt	because there was a ___	pː
Stopp		stop	Ein(e) ___ ist das nicht.	A ___ is this not.	pː
Stopp		stop	Es hat ___ gegeben.	There was a ___.	pː
Stopp		stop	Ich habe den ___ nicht erwartet.	I did not expect the ___.	pː
Stopp		stop	weil es ___ gibt	because there was a ___	pː
straaffed	ʃtrɒːfːət	punish (1.pl.)	Wir ___.	We ___.	fː
straaffsch	ʃtrɒːfːʃ	punish (2.sg.)	Du ___ und ___.	You ___ and ___.	fː
straafft	ʃtrɒːfːtː	punish (3.sg.)	Er ___ und ___.	He ___ and ____.	fː
straffed	ʃtrɒfːət	tighten (1.pl.)	Wir ___.	We ___.	fː
straffsch	ʃtrɒfːʃ	tighten (2.sg.)	Du ___ und ___.	You ___ and ___.	fː
strafft	ʃtrɒfːtː	tighten (3.sg.)	Er ___ und ___.	He ___ and ____.	fː
stülp	ʃtylpː	put over	___ emaal!	___ once! (imp.sg)	pː
stülp		put over	___ nomaal!	___ again! (imp.sg.)	pː
stülp		put over	___ sofort!	___ at once! (imp.sg.)	pː
stülp		put over	___ emaal!	___ once! (imp.sg)	pː
stülp		put over	___ nomaal!	___ again! (imp.sg.)	pː
stülp		put over	___ sofort!	___ at once! (imp.sg.)	pː
stülped	ʃtylpːət	put over (1.pl.)	Wir ___.	We ___.	l
stülped		put over (1.pl.)	Wir ___.	We ___.	pː
stülpsch	ʃtylpːʃ	put over (2.sg.)	Du ___ und ___.	You ___ and ___.	l

Target Word (ZG)			Carrier Phrase (StG)		Cons.
stülpsch		put over (2.sg.)	Du ___ und ___.	You ___ and ___.	pː
stülpt	ʃtylpːtː	put over (3.sg.)	Er ___ und ___.	He ___ and ____.	l
stürmsch	ʃtyːrmʃ	storm (2.sg.)	Du ___ und ___.	You ___ and ___.	m
stürmt	ʃtyːrmt	storm (3.sg.)	Er ___ und ___.	He ___ and ____.	m
Tulpe	tːulpːə	tulip	Ich sage ___.	I say ___.	l
Waffe	ʋɒfːə	weapon	Ich sage ___.	I say ___.	fː
wähled	ʋɛːlət	choose (1.pl.)	Wir ___.	We ___.	l
Wane	ʋɒnə	trough	Ich sage ___.	I say ___.	n
warnsch	ʋɒːrnʃ	warn (2.sg.)	Du ___ und ___.	You ___ and ___.	n
warnt	ʋɒːrntː	warn (3.sg.)	Er ___ und ___.	He ___ and ____.	n
wölb	ʋølp	arch	___ emaal!	___ once! (imp.sg)	p
wölb		arch	___ nomaal!	___ again! (imp.sg.)	p
wölb		arch	___ sofort!	___ at once! (imp.sg.)	p
wölb		arch	___ emaal!	___ once! (imp.sg)	p
wölb		arch	___ nomaal!	___ again! (imp.sg.)	p
wölb		arch	___ sofort!	___ at once! (imp.sg.)	p
wölbed	ʋølpət	arch (1.pl.)	Wir ___.	We ___.	l
wölbed		arch (1.pl.)	Wir ___.	We ___.	p
wölbsch	ʋølpʃ	arch (2.sg.)	Du ___ und ___.	You ___ and ___.	l
wölbsch		arch (2.sg.)	Du ___ und ___.	You ___ and ___.	p
wölbt	ʋølptː	arch (3.sg.)	Er ___ und ___.	He ___ and ____.	l
wünsche	ʋynʃə	wish	Ich sage ___.	I say ___.	n
zähmed	t͡sɛːmet	tame (inf.)	Wir ___.	We ___.	m

III. Abbreviations

acc.	accusative
adj.	adjective
CD	closure duration
CL	Compensatory Lengthening
coll.	colloquial
comp.	comparative
dat.	dative
dim.	diminutive
EPG	electropalatography
f.	feminine
imp.	Imperative
IQR	Inter Quartile Range
inf.	infinitive
infl.	inflection
m.	masculine
ME	Middle English
MHG	Middle High German
MOP	Maximal Onset Principle
MSL	Monosyllabic Lengthening
n.	neuter
nom.	nominative
OCP	Obligatory Contour Principle
OHG	Old High German
OT	Optimality Theory (Prince & Smolensky 1993)
p.p.	past participle
pl.	plural
prep.	preposition
pres.	present
pst.	past
SD	standard deviation
SE	standard error
sg.	singular
SLH	Strict Layer Hypothesis (Selkirk 1984b); also: Strict Layering Principle
SPE	Sound Pattern of English (Chomsky & Halle 1968)
SSP	Sonority Sequencing Principle
StG	Standard German
sbjv	subjunctive
SwG	Swiss German
UR	Underlying Representation
VOT	Voice Onset Time
WbP	Weight-by-Position
ZG	Zurich German